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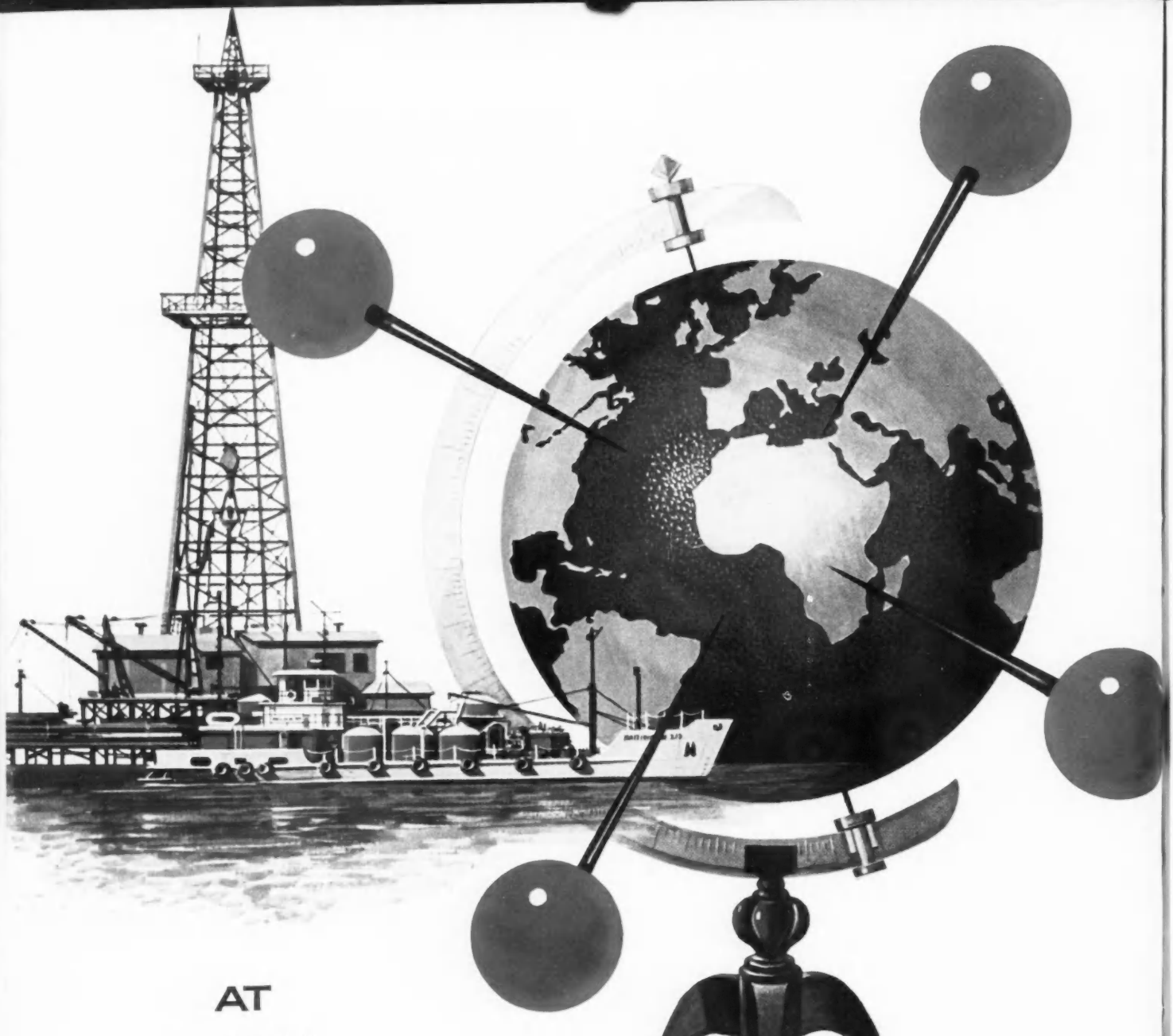

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WORLD OIL

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SPECIALIZED FOR EXPLORATION, DRILLING AND PRODUCING OPERATIONS AND MANAGEMENT

A Quick Look

at This Issue

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

☐ **Engineering-type licensing won't help geologists . . .** The constant, necessary upgrading of the geological profession must be done from within, according to a geologist long experienced in both petroleum exploration and professional society work. In the author's opinion, AAPG fulfills scientific needs but can't fully enforce professional and ethical standards under its current constitutional setup; a new organization, perhaps a reorganized American Geological Institute, *if supported by petroleum geologists,* may remedy geologists' professional and public relations problems ..... **Page 63**

☐ **How to catch better rotary cuttings . . .** A new field-tested semi-automatic sample catcher and washer provides clean, representative formation samples and simplifies gathering procedures. The new device, which has no moving parts and requires virtually no maintenance, is particularly useful for offshore work. It is readily adaptable for use on any rotary rig. . . **Page 65**

☐ **Facies studies can reconstruct oil-forming environments . . .** Recent findings in oceanography have led to more specific determination of shallow and deep-water foraminiferal types. Remains of both types are recognizable in sedimentary rocks. In addition to having provided considerable organic matter for eventual transformation into petroleum, these small organisms, through their fossil remains, give clues to likely source and reservoir rocks, faults, sand lenses and other stratigraphic traps, and provide basic data in the determination of regional depositional events ..... **Page 68**

☐ **How closely is U.S. wildcat drilling controlled by seismograph? . . .** During the past 20 years, U.S. wildcat drilling in a given year has correlated very closely with total seismograph crew months *four years*

QUICK LOOK *continued*

earlier. Hence, from the trend in seismograph party-month totals in 1957, 1958, 1959 and 1960, U.S. wildcatting may decline in 1961 and 1962, increase in 1963, and drop again in 1964. The 1965 wildcat total may depend on the seismograph budget for 1961. But will new exploratory methods modify this correlation? ....Page 72

☐ **Photogeologic leads can be deceptive . . .** Drainage pattern anomalies suggest subsurface oil structures, but two-dimensional drainage analyses alone are not reliable. Other photogeologic criteria including outcrop patterns, surface outcrop lithology, and stream detritus configurations may be used to enhance or condemn drainage anomalies, and to guide geophysical surveys. Such methods may be understood by non-geologists (e.g., in management) as well as being utilized and developed by geologists. Surface faults or fractures may indicate buried stratigraphic traps .....Page 73

☐ **How to analyze strandlines from heavy minerals, facies data . . .** Geologists looking for oil are largely concerned with sands. Where are the oil sands? How can their trends be predicted? Heavy mineral sands can be clues to the environmental sequence. Lagoonal shorelines of barrier islands contain much ilmenite and other heavy minerals. Tidal deltas face inland, and potential reservoir rocks are placed adjacent or close to good source beds for oil .....Page 76

☐ **How to analyze reflection data in permafrost areas . . .** Permafrost can be a problem in seismic work since it may be locally absent even in otherwise continuously frozen areas in the vicinity of large rivers and lakes. Techniques have been worked out to minimize or eliminate effects of permafrost on seismic data, enhancing not only exploration but also future production aspects of the far north since permafrost entails production problems too .....Page 80

☐ **New production facility automated from wellhead to pipe line . . .** Gulf Oil Corporation has installed a new automatic tank battery in South Louisiana for $20,000 less than conventional producing facilities. The battery includes a 15 metering separator stacked production unit, automatic well testing system, LACT and associated treating and pumping equipment. This article describes the installation in detail with emphasis on the custody transfer system .....Page 86

☐ **How to maintain maximum hydraulic horsepower at the bit.** It's an important problem in modern drilling practices, and a closer look at the hydraulic system of a drilling rig is called for. The bit hydraulic horsepower will vary with given drilling practices and hole sizes. Consequently each case must be thoroughly evaluated. This article illustrates graphically how the maximum bit hydraulic horsepower can be obtained at different depths and drilling conditions. .....Page 91

☐ **How to predict sand erosion perforating performance . . .** Field tests and theoretical studies indicate penetration is a function of power applied to the jet, formation hardness, perforation size, nozzle standoff distance, sand concentration and back-pressure. Agreement between test and theoretical data indicates that penetration results can be mathematically predicted. Page 98

☐ **Commercial gas is found in Queensland, Australia . . .** A year of re-examination, geological and geophysical, of the oil and gas potential of Roma, Queensland, Australia, has resulted in the discovery of commercial gas. This is the only commercial production recorded so far in the sub-continent. Application of advanced exploration techniques is responsible for this success. .....Page 101

☐ **Red Cave—the 'Cinderella' of Texas-Oklahoma Panhandles . . .** For 40 years, operators in the Texas Panhandle oil and gas field ignored the potentialities of the Red Cave gas-producing formation, although hundreds of wells reported good shows from this shallow horizon. Then an alert oil operator solved the enigma. The result—some 250,000 additional acres to be prospected. For a detailed report, turn to ....Page 104

☐ **How Secretary Udall views oil and gas. . . .** There is little doubt that Interior Secretary Stewart L. Udall will take an increasing role in petroleum affairs—one far greater than any of his immediate predecessors. For an exclusive report on plans to increase his "leadership functions," turn to WORLD OIL interview, starting on.....Page 126

API coverage to be published Next Month: the most complete

Technical papers from the 1961 regional API meetings are much improved over previous years. The material covers a wider range of subjects—and the technical presentations are excellent.

Be sure to watch for your May API Issue of WORLD OIL. It will contain complete presentations of the most outstanding exploration, drilling, production, and economics papers presented at the regional meetings, plus abstracts and listings of the remaining papers.

Also, a review of the first 100 days of the Kennedy Administration, as related to oil and gas, will be yours for the reading.

Coming in June . . . the International Offshore

Oil Industry In Brief

These are curious times. Some phases of the U.S. oil and gas industry appear to be holding their own. Others aren't. Some oil and gas states appear to be increasing crude oil production out of proportion to reserves. Others aren't.

Couple these contrasts with a stabilized demand growth for domestic crude production and you have fertile seeds for trouble. Trouble that could result in more federal control.

One "seed" is state crude proration. Some states do. Some don't. Producers in prorated states are researching this subject. They are trying to prove that some states are increasing crude production out of proportion to reserves, while states with greater reserves are hurting. If trend proves true, an outside arbiter may step in to put things back in focus.

Another "seed" is small tract vs. large tract drilling. New Texas group has been formed to protect small tract owners' "property rights"—as immediate aftermath of Texas Supreme Court ruling in Normanna case. Large tract advocates have long contended that small tract drilling violates principles of good conservation—gives owners returns out of proportion to investment. If reasonable compromise isn't reached on this touchy issue, an outside arbiter may step in to set things right.

The arbiter stepped in to control natural gas prices at the wellhead. Also crude and products imports. The same could happen on the above two issues.

Which brings to mind a pertinent question. Who will be the arbiter when consumer rights and industry's economic freedoms are consumed by greater federal control?

Operations Issue

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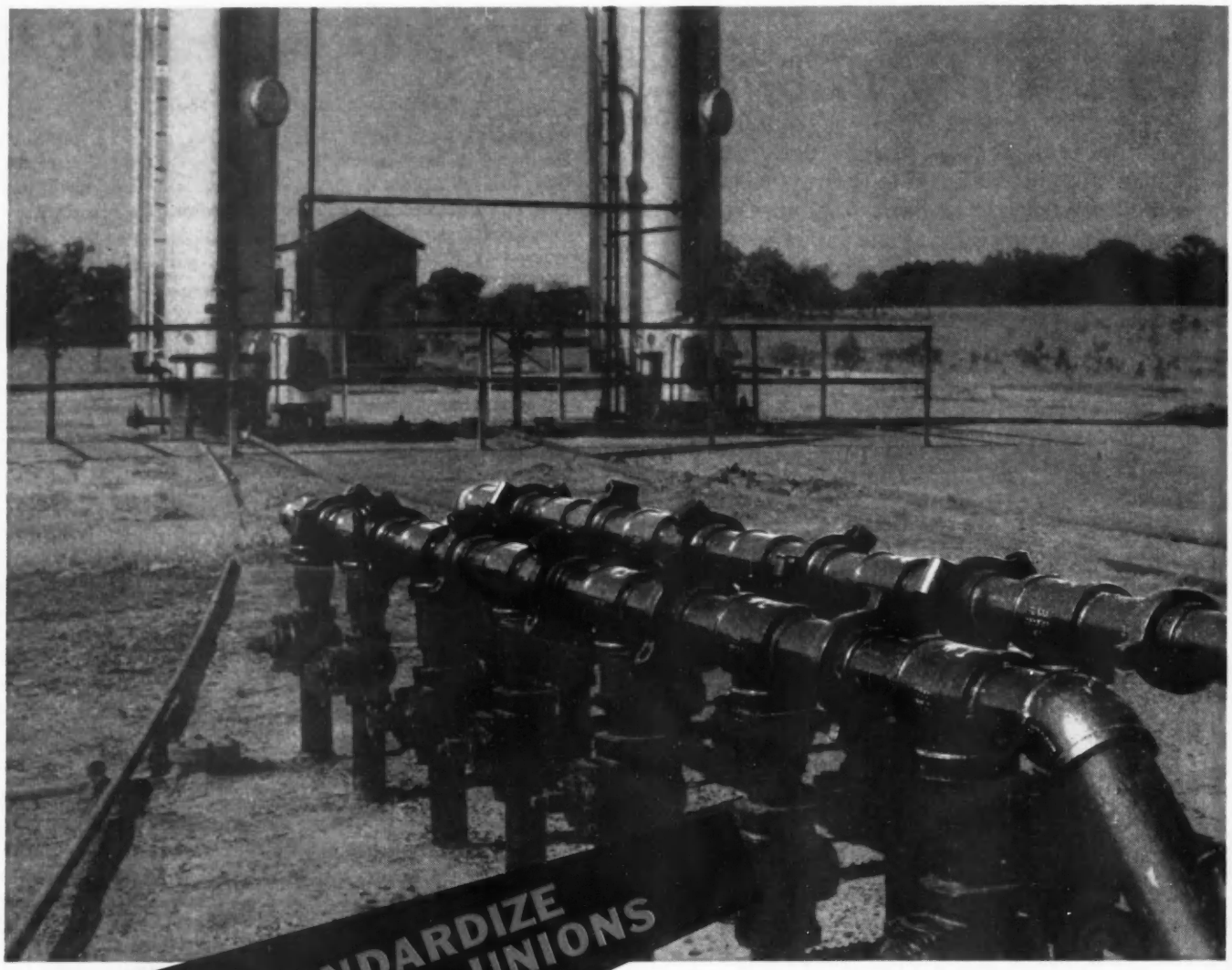

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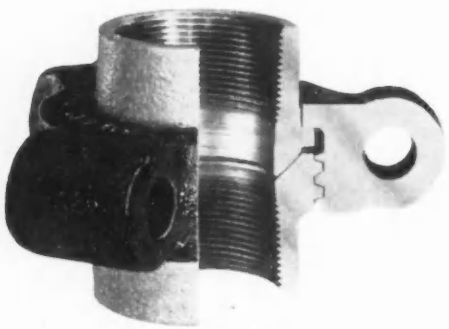

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Looking Ahead

California's first underwater completion . . . Richfield Oil has just completed another step in transition from platform-type offshore operations to less expensive ocean floor completion. Located in 55 feet of water about ¾-mile off the coast between Ventura and Santa Barbara, the well was drilled and flow lines laid from a floating drilling barge. Final connections were made with divers.

Ventura well, resembling Richfield's completion last year in 132 feet of water off coast of Peru, has specially designed wellhead encased in a steel housing. Well presently is producing, flowing, 75 barrels per day of 29 gravity crude. Production flows through one of a bundle of three 2-inch, extra-heavy steel flow lines. Second line in bundle is a hydraulic control line. Third is for gas lift operations when and if artificial lift becomes necessary.

Well was drilled to 2,290 feet, but was plugged back to 2,110 feet. Surface string of 13⅜-inch was cemented at 380 feet, and combination string of 10¾ and 8⅝-inch was cemented at 1,940 feet. A 5½-inch liner was hung at 2,109 feet.

Impending shortage of geologists—petroleum engineers? . . . Texas University Petroleum Engineering Department Chairman Dr. Carl Gatlin reports national total for bachelor's degrees in petroleum engineering dropped from about 800 in 1957 to 400 in 1960. Result: "A drastic shortage of college petroleum engineering graduates is developing and will become acute by 1962."

World Oil surveys show major oil companies are generally stepping up hiring of geologists, particularly those completing work on masters degrees or doctorates. Outlook is for a shortage of oil geologists and geophysicists by 1963 if exploration effort increases as anticipated.

Initial Mohole operation successful . . . First Mohole drilling operation, conducted in 3,140 feet of water from un-moored drilling vessel Cuss 1 near San Diego can be considered successful. Five holes, each ranging in depth from several hundred feet to maximum of 1,043 feet, were drilled without incident. Deepest core taken was from 750 feet.

Key to success of operation, and one of the prime objectives of initial shallow tests, was the ability to hold vessel centered over the hole using specially designed 200-horsepower diesel outboard motors attached at each quarter of the ship.

If all goes well, next step will be major test in 12,000 feet of water near Guadalupe Island, about 90 miles off the Baja, Calif. coast.

Drill string used in initial test included 4½-inch internal flush drill pipe, with 7½-inch O.D. by 3½-inch I.D. drill collars. A 9-inch diamond core head and barrel, designed for wire line core recovery, was equipped so as to be adaptable to varying formation conditions encountered.

Multiple completions increase at steady pace . . . Five years ago, 913 duals represented all the multiple completions in Texas. By 1958, the total had increased to 2 triples and 1,427 duals. Last year, Texas reported 1,681 duals, 123 triples, 11 quadruples, and 1 sextuple—more than double the multiple completions reported in 1955.

Dual weight drill pipe passes field tests . . . This new type drill pipe has been used in 82,000 feet of hole with high success. Dual weight pipe combines weight-saving advantages of light weight pipe with strength of regular drill pipe—in common API grades and sizes.

Good Wells Make Good News

A Report on Interesting Acidizing Treatments by Dowell

April, 1961

These four recent examples demonstrate a few of the many well conditions that respond to Dowell acidizing.

- **Alberta, Canada** (New Gas Well) When a drill stem test yielded 4 mmcfd, operator decided to complete this wildcat. Pay is the Mississippian lime between 6971 and 7013 feet. Porosity is 5.1 per cent. Solubility is 95.5 per cent. Average permeability of the interval is one millidarcy. There are short, more permeable sections at two levels within this interval. These permeable sections were perforated, washed with BDA* Breakdown Acid and acidized. 30,000 gallons of a special Retarded Acid, with a fluid loss additive, were injected using three Allison-powered pumpers. The Acid Guide* was used to plan this treatment. Production test before treatment was 100 mcfd. After treatment well tested 14.2 mmcfd at 1900 psi on ½-inch choke. (Calculated open flow was 35 mmcfd.)

- **Tom Green County, West Texas** (Abandoned Oil Well) This well in the Mertzon-San Angelo pool had originally been perforated and acidized. It was abandoned temporarily after producing only 3 barrels of oil and eight barrels of water per day. Recently, Dowell was called to help recomplete the well. First, the old perforations from 1550 to 1565 feet were squeezed off using 125 sacks of cement modified with FLAC* fluid loss additive for cement. Next, three holes were jetted at 1558 feet with Abrasijet* -- Dowell's abrasive jetting service. Then the well was acidized with 500 gallons regular acid. After clean-up, well tested 100 bopd; no water.

- **Texas County, Oklahoma** (New Gas Well) A lower section of the Topeka lime (3182 to 3198 feet) tested 3 mmcfd after being perforated and acidized. A plug was set above this section and an upper zone was then perforated from 3090 to 3160 feet. When it also tested 3 mmcfd, communication was suspected. Dowell suggested selective acidizing using rock salt as a temporary plugging material. The upper section was acidized with 15,000 gallons Dowell acid containing demulsifier, surfactant and a silicate control agent. 4000 pounds of rock salt were used in three stages during treatment to block communication with the lower zone and to divert acid into the less permeable sections of the upper zone. After well was swabbed and cleaned up, it tested 14.5 mmcfd from the two zones combined.

- **Lafourche Parish, South Louisiana** (Old Oil Well) This well in the Miocene was mudded off during workover and would not come in despite good porosity and permeability. Dowell acidized with 500 gallons Mud Acid injected between 250-gallon slugs of regular acid containing a demulsifier and an agent to lower surface tension. Injection rate was one bpm at 1700 psi. After acid was swabbed out, well made 115 bopd allowable.

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Services for the oil industry DOWELL

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The petroleum industry needs more geologists

By Mason L. Hill
President-elect, American Association of Petroleum Geologists
Manager of Exploration, Richfield Oil Corp.

PETROLEUM GEOLOGISTS are especially concerned over the current decrease in job opportunities. This situation is largely, but I believe illogically, due to the present world over-supply of oil. Consequently, both large and small oil companies have curtailed exploration. It appears that geologists and geophysicists have been so successful during the last few years that they no longer are in demand.

Many companies actually have terminated a large proportion of their geologists and very few newly-trained men have been employed. This is a bad situation for practicing and potential petroleum geologists; but, apparently unrecognized by some, it can be disastrous to the U.S. petroleum industry.

It is inevitable that rising demand for oil will again approach the available supply. This can result also from various economic and political situations which cannot be accurately anticipated. Furthermore, the demand for U.S. oil, perhaps sooner than generally expected, again may become urgent. This means substantial new U.S. reserves need to be proved years in advance so ultimate producing capacity can meet these demands. When the next U.S. supply crisis becomes imminent, geologists cannot be immediately reinjected into the industry, either from the now-swelling ranks of ex-petroleum geologists or from the newly-trained, because they—unlike nuts and bolts—are not produced on short notice.

It must be recognized that development of good geologists takes at least five years of higher education, plus three years of training. If these geologists are not available on a continuing basis, in spite of fluctuations in the economy of the oil business, they will not be available when needed. This could be disastrous because the failure to provide adequate domestic supplies and reserves of petroleum will be detrimental to the U.S. industry and to the national economy and defense.

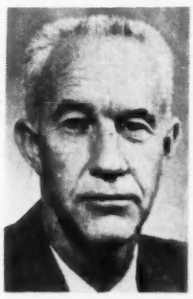
If a minority of all geologists were employed by the oil industry, geologic training and employment might be stabilized. However, since the vast majority work in this industry, periodic geologic unemployment is certainly an oil industry problem and responsibility. It is, perhaps, most important that a nearly stabilized number of well-educated (not just trained) geologists be taken from the better graduate schools each year. This would encourage an adequate number of good science students to enter the field of geology and thus to become available to the oil industry as needed.

The present drastic drop in the employment of petroleum geologists already has resulted in a paralleling reduction of undergraduate students in geology. Until the petroleum industry modifies its hot and cold interest in geologists, too many of the poorly-educated—or too few of the well-educated—will be alternately employed.

Furthermore, the industry also could profit, especially in slack exploratory periods, by establishing training pro-

About the Author

Mason L. Hill is president-elect of The American Association of Petroleum Geologists. His installation as president will take place at Denver, Colorado, during the joint AAPG-SEPM annual meeting, April 24-27. Hill is exploration manager, Richfield Oil Corporation, Los Angeles. He received his B.A. degree in geology from Pomona College in 1926, his M.A. from Claremont College in 1929, and his doctorate from the University of Wisconsin in 1932. Hill interspersed graduate studies with geologic work for Shell Oil Company from 1927 to 1930; instructed at Coalinga Junior College from 1932 to 1934; and returned to Shell in 1934 before joining Richfield in 1937. Recent discoveries by Richfield at Cuyama Valley, California and Swanson River, Alaska reflect his work and that of the highly competent staff he has developed. In addition to Hill's AAPG committee activities, he was president of the Pacific Section of AAPG in 1955-56. He is also a member of Theta Tau and a fellow of GSA.



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GUEST EDITORIAL *Continued*

grams to give their geologists and geophysicists a broader knowledge of exploration practices and other aspects of the oil industry. Too few geologists ever really know, for example, the principles and techniques of photogeology, field geology or geophysics. And too few appreciate the importance of other phases of the industry, as for example, economics, legal aspects, or drilling and production practices.

The current trend toward unemployment of U.S. geologists would be reversed if large quantities of oil from abroad became unavailable. However, ex-petroleum geologists and college science students cannot wait for such a development.

On the other hand, our industry and our country must be prepared for this very possibility (remember Suez).

The solution to this problem, which surely will be a surprise to some, is to continue the employment of good geologists and instigate regular hiring of newly-educated geologists to pursue, more scientifically and consistently the search for oil in the U.S. Since the value of the application of geology to oil exploration is firmly established, and until some better method is developed, more geology is the answer.

Under the present condition of over-supply, which is shrinking the availability of risk money, this must be done on smaller budgets. I believe this is both simple and practical if extra effort is concentrated on refining the scientific and technological applications of geology and geophysics, while temporarily curtailing some of the more expensive wildcat drilling and seismic work.

For example, a year's salary for 100 geologists might cost less than one dry hole or one crew year of seismic work. Actually, more and better geologists doing better geology by better methods will have better plays ready (in hip pockets, map files and perhaps on punch cards) when the money becomes available for more intensive exploration drilling.

Also, more and better geophysicists, reworking old information and developing new techniques, will be ready, with geologists, to contribute more efficiently in meeting the inevitable challenge to find more oil and gas in the United States. In this manner, a stabilized scientific effort could be maintained in spite of short-term fluctuations in the economic climate of the petroleum industry.

Thus my conclusion is that more geologists are needed now for oil and gas exploration at home. These geologists should be developed within the industry and regularly recruited from graduate schools to apply the basic principles of geology in a continued search for petroleum reserves. With a little justified faith and with the development and use of better educated and experienced geologists and geophysicists, the health of the U.S. petroleum industry, and even the U.S. economy, can be gradually improved and protected.

Actually, there is no known limit to future discoverable petroleum reserves in the U.S. With more and better scientific work these reserves can become available as required, even in competition with imported oil. The time has come to eliminate "off and on" exploration. My recommendation is that we get to work.

Oil use high but seasonable drop approaches

By WORLD OIL Staff

INDUSTRY RESULTS have been exceptionally good in the early part of 1961. Total demand for petroleum has been strong and supplies have been kept at reasonable levels.

Continuance of a favorable situation also is generally expected. Strong demand for petroleum in January and February was based primarily on exceptionally cold weather. Consumption of distillate fuel oil was very high in meeting requirements for heating purposes. Kerosine demand was stimulated by the cold weather besides being good in meeting growing requirements for commercial jet planes.

Gasoline demand has continued to lag. But cold weather probably has been partially responsible. Residual fuel oil consumption has been lower than a year ago, despite the usual use of some quantities for heating. The slow rates of consumption apparently have reflected lagging industrial production and scarcity of supplies, due to limited domestic production and restricted imports.

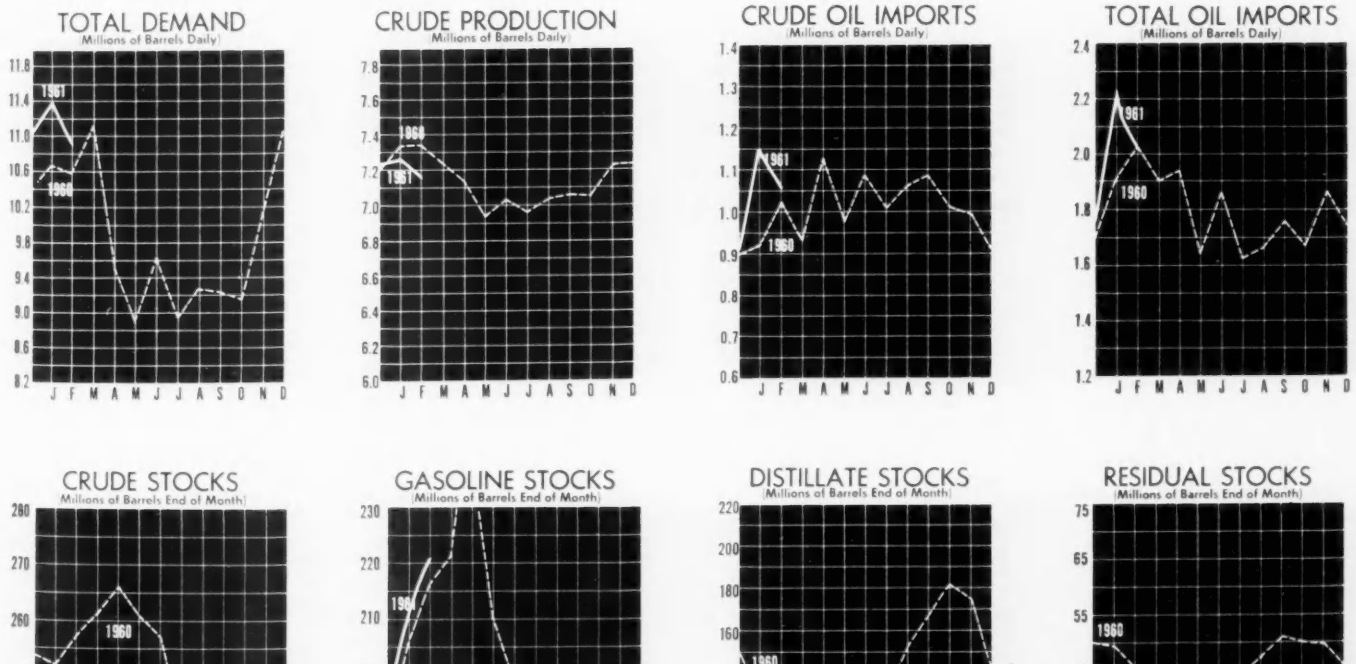
Henceforth the weather will not be a stimulant to demand, except that milder days will cause the usual seasonal expansion of consumption of gasoline for agricultural, travel and other purposes.

The best hope for good demand for petroleum in the future lies in the generally expected improvement of business conditions generally around the middle of the year and during the third and fourth quarters. Better business could be expected to result in good demand for gasoline, diesel fuel, lubricants, residual fuel oil, kerosine for airlines and other petroleum products.

While the petroleum demand situation and outlook are favorable, the need to keep supplies in balance with demand is generally recognized in the industry. Following earlier imbalance, the industry began to achieve a better balance between supply and demand at the middle of last year. Subsequently it has been maintaining a satisfactory supply-demand situation. Currently, stocks of crude oil and products are generally at reasonable levels.

Total stocks of all oils, at 741 million barrels, are 39 million or 5 percent lower than one year ago. Crude oil stocks are down sharply, and decreases are shown by distillate fuel oil and residual fuel oil. Kerosine stocks are up somewhat, but so is the demand for that product. Gasoline stocks are 4 million barrels or 1.8 percent

Petroleum Trends...



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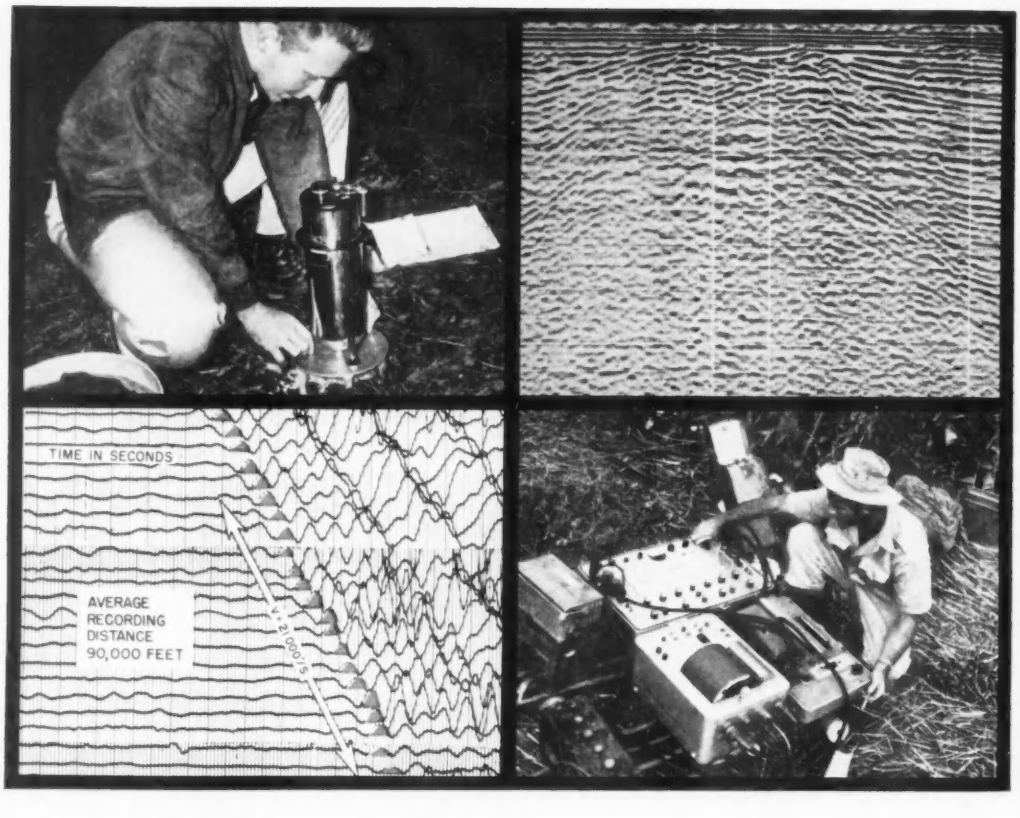

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Number 4 of a Series

above a year ago, and may be somewhat larger than desirable, though gasoline demand is up 1.1 percent so far in 1961.

Total new supply of oils has been held down well in line with requirements. In the first two months of 1961 it was only 176,000 barrels per day or 1.7 percent greater than in the like period of 1960. This increase seemed justified by the trend of total demand for petroleum, which was up 514,000 bpd or 4.8 percent for January and February.

While total new supply was up only moderately from last year, the restraint which was exercised was credited to domestic crude oil producers. U.S. crude output was off 61,000 bpd or 1 percent, while imports were up 91,000 bpd or 8.4 percent, and production of natural gas liquids was up 72,000 bpd or 7.6 percent.

Refinery runs have been moderate, in reflection of strict controls on crude oil production and imports, which have limited crude supplies to refiners. U.S. crude runs to stills in the January-February 1961 period averaged 8,366,000 bpd, an increase of only 190,000 bpd or 2.3 percent over the like period of 1960.

At mid-March it appeared that the industry's statistical situation might turn somewhat less favorable by the end of the month. Two important factors that caused some anxiety were the mild weather, which threatened to hold down consumption of heating oils for the month, and the increased production of crude oil during March, under higher allowables in Texas. The continued lagging of general business also was a factor on the unfavorable side.

The industry also now is entering upon the period of several months in which total consumption of petroleum will be at the lowest levels of the year because of seasonal trends. Use of heating oils will decrease sharply, and consumption of gasoline will expand only gradually until vacations come along in June and July.

The Texas Railroad Commission has given recognition to the prospective seasonal decline in demand for petroleum by ordering lower crude production allowables in April. The lower quotas should help to hold refinery runs at reasonable levels.

On the whole, the outlook is promising, but there is still need for moderation in industry operations.

U.S. Petroleum Demand and Supply (Thous. Bbls. Daily)

ITEM	February 1961	February 1960	% Diff.	Jan. 1961	January-February 1961	January-February 1960	% Diff.
DEMAND							
All Oils, Total Demand	10,906	10,595	+ 2.9	11,369	11,149	10,635	+ 4.8
Domestic Demand	10,726	10,395	+ 3.2	11,197	10,973	10,438	+ 5.1
Export Demand	180	200	—10.0	172	176	197	—10.7
Gasoline, Total Demand	3,776	3,786	— 0.3	3,711	3,742	3,700	+ 1.1
Distillate, Total Demand	2,825	2,553	+10.7	3,081	2,960	2,684	+10.3
Kerosine, Total Demand	549	483	+13.7	600	576	481	+19.6
Residual, Total Demand	1,832	1,982	— 7.6	1,908	1,872	2,013	— 7.0
Other Oils, Total Demand	1,924	1,791	+ 7.4	2,069	1,999	1,757	+13.8
CHANGE IN STOCKS							
All Oils, Change in Stocks	—647	—365	.....	—971	—817	—478	.....
NEW SUPPLY							
Total New Supply	10,259	10,230	+ 0.3	10,398	10,332	10,156	+ 1.7
Domestic Production, Total	8,221	8,192	+ 0.4	8,168	8,193	8,183	+ 0.1
Crude Oil	7,186	7,241	— 0.8	7,163	7,174	7,235	— 0.9
Natural Gas Liquids	1,035	951	+ 8.8	1,005	1,019	947	+ 7.6
Imports, Total	2,038	2,038	.....	2,230	2,139	1,974	+ 8.4
Refined Products	985	1,013	— 2.8	1,080	1,035	1,002	+ 3.3
Crude Oil, Total	1,053	1,025	+ 2.7	1,150	1,104	972	+13.6
Crude, East of California	843	771	+ 9.3	827	834	737	+13.2
CRUDE RUNS							
Crude Runs to Stills	8,413	8,065	+ 4.3	8,323	8,366	8,176	+ 2.3
Domestic Crude	7,342	7,068	+ 3.9	7,277	7,308	7,216	+ 1.3
Foreign	1,071	997	+ 7.4	1,046	1,058	960	+10.2

U.S. Stocks of Oils (Million Bbls. at End of Month)

KIND OF OIL	TOTAL IN U.S. Feb. 1961	TOTAL IN U.S. Feb. 1960	% Diff.	TOTAL IN U.S. Jan. 1961	EAST OF CALIFORNIA Feb. 1961	EAST OF CALIFORNIA Feb. 1960	% Diff.	EAST OF CALIFORNIA Jan. 1961
All Oils	741.1	780.2	— 5.0	759.2	.....	.....	.....	.....
Crude Oil	230.5	257.0	—10.3	234.9	201.3	222.5	— 9.5	204.6
Natural Gas Liquids	25.0	20.8	+20.2	26.5	.....	.....	.....	.....
Gasoline	221.1	217.1	+ 1.8	211.8	191.9	185.6	+ 3.4	182.2
Distillate Fuel Oil	96.6	105.0	— 8.0	111.8	82.9	93.8	—11.6	98.6
Kerosine	24.3	23.0	+ 5.7	27.4	22.7	21.9	+ 3.7	25.8
Residual Fuel	43.1	45.8	— 5.9	44.0	30.5	29.5	+ 3.4	31.3
Other Products	100.5	111.5	— 9.9	102.8	.....	.....	.....	.....

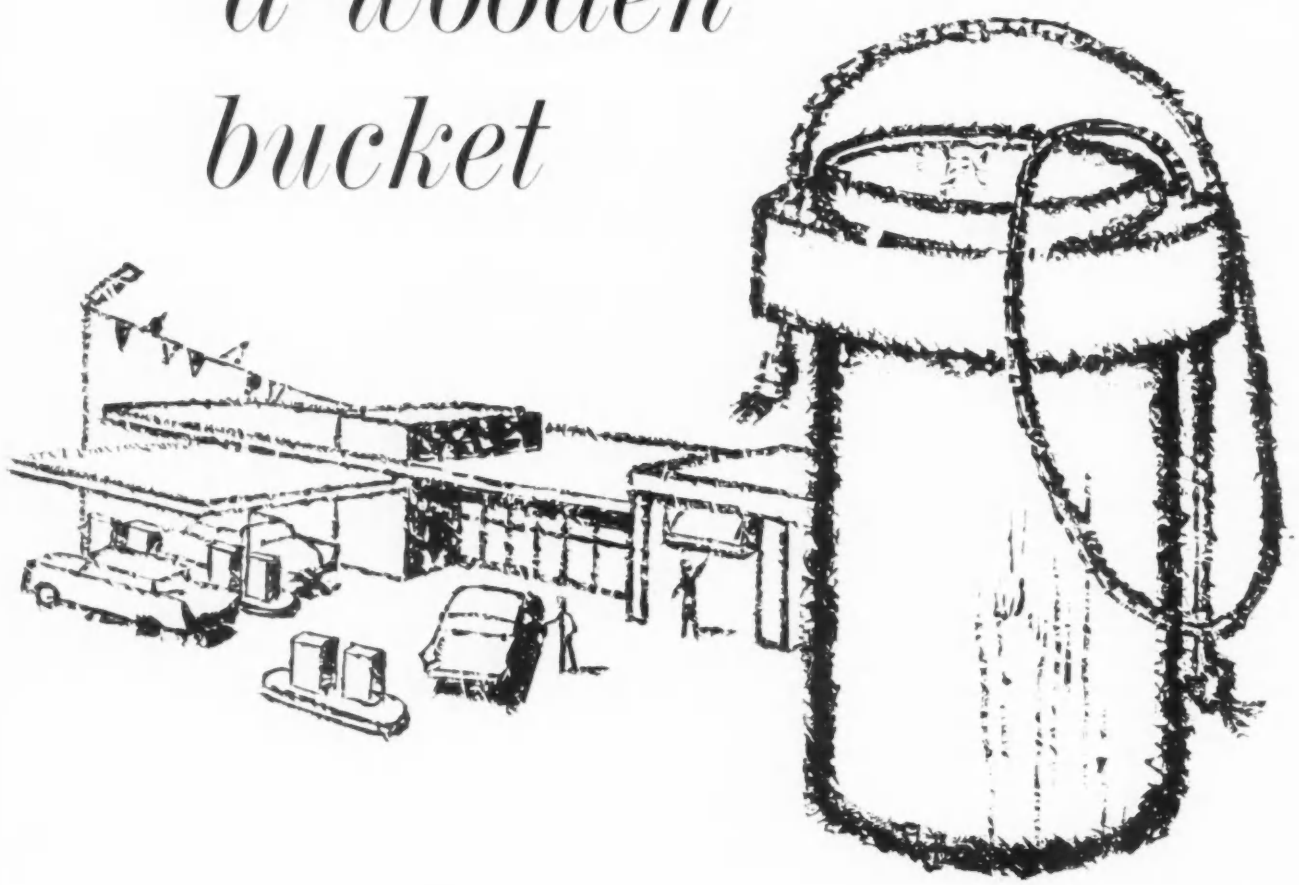
U.S. Crude Oil Production, by States (Thous. Bbls.)

STATE or DISTRICT	Daily Average for Month Feb. 1961	Feb. 1960	% Diff.	Jan. 1961	Total, January-February 1961	1960	% Diff.
Alabama	21.1	15.2	+ 38.8	21.3	1,251	932	+ 34.2
Arkansas	78.2	81.7	— 4.3	75.9	4,540	4,552	— 0.3
California	825.4	827.7	— 0.3	833.4	48,948	49,698	— 1.5
Colorado	131.5	127.6	+ 3.1	131.9	7,770	7,664	+ 1.4
Florida	1.0	1.2	— 16.7	1.0	57	70	— 18.6
Illinois	212.4	212.8	— 0.2	216.4	12,656	13,045	— 3.0
Indiana	32.8	32.4	+ 1.2	33.0	1,942	1,948	— 0.3
Kansas	302.8	308.3	— 1.8	294.4	17,603	18,675	— 5.8
Kentucky	52.0	59.5	— 12.6	53.4	3,113	3,698	— 15.8
Louisiana	1,141.0	1,079.3	+ 5.7	1,126.4	66,867	64,921	+ 3.0
North Louisiana	111.6	123.0	— 9.3	110.4	6,546	7,375	— 11.3
South Louisiana	1,029.4	956.3	+ 7.6	1,016.0	60,321	57,546	+ 4.8
Michigan	52.2	35.2	+ 48.3	51.1	3,044	2,048	+ 48.6
Mississippi	150.6	144.0	+ 4.6	151.1	8,902	8,827	+ 0.8
Mo.-So. Dak.-Tenn.	0.6	0.6	.....	0.6	37	30	+ 23.3
Montana	80.9	85.0	— 4.8	80.3	4,756	5,022	— 5.3
Nebraska	66.1	62.7	+ 5.4	64.9	3,862	3,805	+ 1.5
Nev.-Wash.-Alaska-Ariz.	7.2	0.9	+700.0	4.4	339	51	+564.7
New Mexico	302.0	304.8	— 0.9	298.0	17,697	18,163	— 2.6
Southeast	266.0	256.9	+ 3.5	263.0	15,613	15,404	+ 1.4
Northwest	36.0	47.9	— 24.9	35.0	2,084	2,759	— 24.5
New York-Pennsylvania	19.1	22.0	— 13.2	19.3	1,135	1,298	— 12.6
North Dakota	67.7	61.9	+ 9.4	67.1	3,975	3,583	+ 10.9
Ohio	12.0	13.8	— 13.1	11.6	696	833	— 16.5
Oklahoma	513.0	557.2	— 7.9	519.2	30,458	33,499	— 9.1
Texas	2,623.4	2,740.9	— 4.3	2,611.9	154,426	163,635	— 5.6
Dist. 1: South Central	45.7	44.5	+ 2.7	45.8	2,702	2,625	+ 2.9
Dist. 2: Middle Gulf	114.9	127.5	— 9.9	115.5	6,799	7,463	— 8.9
Dist. 3: Upper Gulf	363.3	390.2	— 6.9	364.0	21,456	23,042	— 6.9
Dist. 4: Lower Gulf	193.2	202.7	— 4.7	192.5	11,377	11,757	— 3.2
Dist. 5: East Central	27.5	27.7	— 0.7	27.4	1,619	1,652	— 2.0
Dist. 6: Northeast	257.4	273.9	— 6.0	255.3	15,123	16,103	— 6.1
Dist. 7-B: North Central	128.6	138.9	— 7.4	126.4	7,517	8,228	— 8.7
Dist. 7-C: West Central	118.7	133.1	— 10.8	119.4	7,024	7,800	— 10.0
Dist. 8: West	1,075.5	1,136.2	— 5.4	1,065.1	63,133	66,544	— 5.1
Dist. 9: North	194.2	194.2	.....	197.0	11,543	11,679	— 1.2
Dist. 10: Panhandle	104.4	109.4	— 4.6	103.5	6,133	6,562	— 6.5
Utah	103.3	109.3	— 5.5	109.1	6,276	6,588	— 4.7
Virginia	.....	.....	.....	.....	.....	1	.....
West Virginia	6.3	5.6	+ 12.5	5.9	358	328	+ 9.1
Wyoming	383.2	351.3	+ 9.1	381.3	22,548	21,212	+ 6.3
Total, U.S.	7,185.8	7,240.9	— 0.8	7,162.9	423,256	434,126	— 2.5

Sources for above 3 tables: Bureau of Mines monthly reports, except last two months based on API and B. of M. weekly reports and WORLD OIL estimates, and Texas districts from API.

Number 4 of a Series
TELL THIS PETROLEUM INDUSTRY FACT TO YOUR NEIGHBOR

It started with a wooden bucket



A long the early rutted trails of Pennsylvania rolled the Conestoga wagons with a wooden tar-bucket slung from the rear axle. Teamsters swabbed smoking hubs with a mixture of tar and lard, or with petroleum seepage when they could find it. That tar-bucket is the ancestor of the service stations that today pump 42 billion gallons of motor fuels into passenger cars and trucks each year.

This necessity is taxed more than most luxuries; Federal and state taxes add nearly 50% to the price of gasoline. The petroleum industry has developed better fuels at lower actual cost, but taxes have eliminated any benefit to the consumer. Since 1925, *taxes* on gasoline have increased 380%. The average price of gasoline (not including taxes) has increased *only 1%* during the same period. No other industry has made so many product improvements with so small an increase in actual cost during this period of declining dollar purchasing power.

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6103

Drilling to increase in second quarter

By **WORLD OIL STAFF**

U.S. DRILLING activity turned upward in March and the trend will continue to improve during the second quarter. However, the levels will stay well below previous years.

The statistics for January and February tell a different story—well completions averaged 115 per day, down 8 percent from the 125 completions reported daily during January-February 1960. Footage drilled averaged 470,903 feet per day, down 11.1 percent from the same 1960 period. During February 1961:

- **Well completions** averaged 113 per day, down 3.8 percent from the January average of 117 daily, and down 5 percent from the 119 completions per day in February 1960.
- **Footage drilled** averaged 451,047 feet per day, down 7.7 percent from January and 9.5 percent from February 1960.
- **Operating rigs** totaled 3,171 on February 28, down 54 from January, and 219 from February 29, 1960.
- **Wildcatting activity** averaged 20 wells per day, down 13 percent from January, and 9.1 percent from February 1960.

U. S. Drilling Activity in February and First Two Months, 1961

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED									WILDCATS COMPLETED						†Active Rigs End of Month
	February							Jan.-Feb.		February					Jan.-Feb. Total	
	Oil	Dist.	Gas	Dry	Service	Total Wells	Total Footage	Total Wells	Total Footage	Oil	Dist.	Gas	Dry	Tot.		
Alabama	1					1	11,482	3	25,749							7
Alaska	2			1		3	34,567	5	51,417				1	1	1	8
Arizona								1	1,180							2
Arkansas	24		1	22		47	169,810	89	348,534				6	6	19	32
California	80		15	24	5	124	534,567	269	1,120,861			1	17	18	30	126
Colorado	6		1	23		30	160,447	83	398,983			1	14	15	46	42
Illinois	58		6	52		116	258,674	345	761,333	4		1	23	28	90	177
Indiana	32		1	47		80	139,659	150	243,499				17	17	34	110
Kansas	135		17	165	18	335	1,202,467	749	2,673,972	5		1	50	56	111	220
Kentucky	107		22	58		187	129,268	397	289,956	1			2	3	8	143
Louisiana	62	8	23	85		178	1,240,919	424	3,184,554				24	24	47	310
North La.	31		17	31		79	280,300	164	565,683				12	12	19	56
South La.	31	8	6	54		99	960,619	260	2,618,871				12	12	28	254
* Gulf of Mexico	7	1	2	6		16	156,739	54	567,178				1	1	3	64
Michigan	19		4	29		52	175,781	117	388,778	3			17	20	52	80
Mississippi	14			18		32	318,535	85	855,516				9	9	26	51
Missouri				1		1	3,375	2	4,775							2
Montana	6		2	21		29	152,764	65	332,927	1			13	14	23	16
Nebraska	21			28		49	221,628	113	540,267	2			20	22	62	36
New Mexico	75		36	36		147	747,234	291	1,523,789	10			17	27	45	114
Southeast N. M.	60		4	23		87	449,780	175	901,731	9			14	23	38	64
Northwest N. M.	15		32	13		60	297,454	116	622,058	1			3	4	7	50
New York	15		3	3	7	28	43,925	56	87,850							25
North Dakota	8			5		13	77,800	25	160,941				1	1	3	16
Ohio	54		22	12		88	219,021	165	424,169	1		2	1	4	10	118
Oklahoma	248	13	33	111	58	463	1,615,446	770	2,808,358	4	2	2	23	31	70	410
Pennsylvania	18		17	5	9	49	139,091	101	288,709			1		1	4	53
South Dakota								1	8,633						1	
Tennessee	2			8		10	3,850	22	8,448				5	5	12	20
Texas	494	12	101	292	11	910	4,241,590	2,110	9,773,003	15	2	10	168	195	472	806
District—																
1: South Central	22		1	19	1	43	139,750	104	337,915			1	15	16	39	29
2: Middle Gulf	15		22	13		50	360,256	112	787,038	1		4	9	14	36	57
3: Upper Gulf	41	11	6	22		80	536,746	201	1,414,276		2	1	9	12	52	85
* Gulf of Mexico																2
4: Lower Gulf-S.W.	43		14	35	1	93	482,535	200	1,043,057	1		1	18	20	44	82
5: East Central	2		2	13		17	110,109	29	195,196	1			10	11	17	19
6: Northeast	40	1	3	5		49	257,304	117	628,271				4	4	17	44
7-B: North Central	65		6	45		116	366,909	288	901,634	5		1	34	40	104	88
7-C: West Central	20		2	26		48	185,026	97	430,657				18	18	39	68
8: West	136		8	47	1	192	1,095,124	419	2,297,384	6		1	25	32	64	143
9: North	80		7	51	8	146	380,225	349	914,184	1			20	21	46	103
10: Panhandle	30		30	16		76	327,606	194	823,391			1	6	7	14	88
Utah	3	1	3	7		14	77,513	27	170,218	1		2	6	9	18	35
Washington				3		3	10,706	4	17,206				2	2	3	1
West Virginia	17		56	7		80	189,878	188	478,203							160
Wyoming	29		7	52	5	93	482,401	145	779,813	2			31	33	53	43
Others				4		4	26,905	6	31,611				4	4	6	8
Total U.S.:																
February 1961	1,530	34	370	1,119	113	3,166	12,629,303	6,808	27,783,252	49	4	21	471	545	1,246	3,171
January, 1961	1,723	36	399	1,412	72	3,642	15,153,949			49	4	17	631	701		3,225
February, 1960	1,702	61	331	1,282	70	3,446	14,450,583	7,523	31,784,397	32	6	17	582	637	1,544	3,390
Western Canada:																
February, 1961	82		26	67		175	1,029,232	360	1,989,735							195
January, 1961	103		18	59	5	185	960,503									246
February, 1960	126		21	77		224	1,270,463	466	2,631,744							256

* Gulf of Mexico wells are included in their respective district totals. † Includes wells rigging up, drilling, and temporarily shut-down.

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. . . Greater flexibility for working down the hole.

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- Each string operates independently.
- Each formation selects own operating valve based on deliverability and pressure.
- Each formation may intermit or constant flow, based on deliverability.

Outstanding advantages in multiple tubing installations:

FIRST: All valves are alike and may be placed in the string without regard to dome pressure.

SECOND: Each string automatically selects its own working valve, based on formation deliverability.

THIRD: All valves are tubing sensitive and admit gas as required by the fluid rise in the tubing.

FOURTH: Each formation is produced as constant or intermittent flow, depending on operating pressure and formation deliverability.

FIFTH: Both constant or intermittent flow may occur simultaneously from separate formations.

THE AUTOMATIC STABILIZER MAY BE ADDED TO CONVENTIONAL PRESSURE CHARGED VALVES FOR A NOMINAL COST, THUS EASING THE OBSOLESCENCE PROBLEM.

Practical Operating Hints

These How-To-Do-It Ideas Can Save You Money

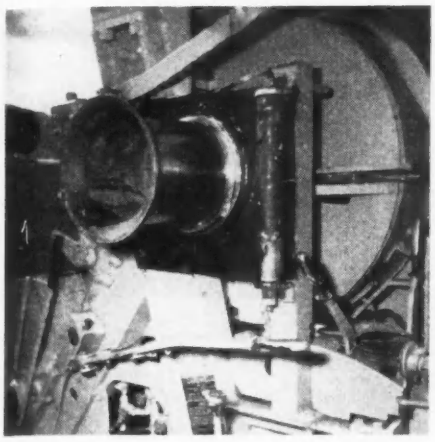
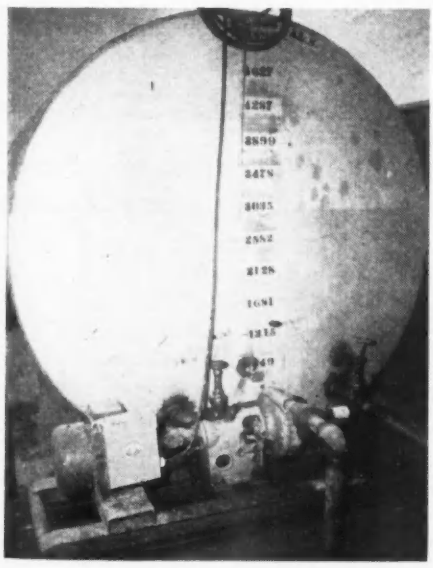


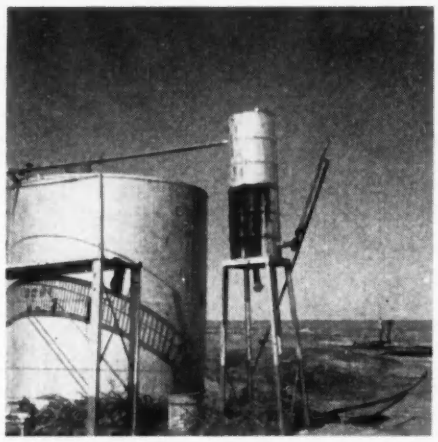
Plate Behind Cathead Prevents Fouling of Catline

A plate with the female end of a thread protector installed inside of the cathead will prevent once and for all the wrapping of the catline inside of the cathead. It is only necessary to remove the roller beside the cathead and slip on the plate which is made from the end of a surface casing protector, and a quarter-inch plate. Holes are burnt in the corners of the plate to match holes in the frame of the drawworks.



Electric Motor and Pump Saves Fuel Tank Support

One contractor found that it was more convenient to dispense with the heavy support which would hold his fuel tanks high enough to gravitate fuel over to the engines and rigged up this centrifugal pump and motor to do the job. No matter how high the engines are, the day tanks can be filled at the beginning of each tour with the use of the pump. Where diesel fuel is needed for cleaning purposes, another connection is made on the tank. A piece of plastic garden hose serves as the fuel gage.



Make Gun Barrel From Used Drums

This stripper operator has constructed a workable gun barrel by welding two 55-gallon drums end to end and providing appropriate connections in the sides. A one-inch water leg is installed as shown and the complete unit is mounted on a platform constructed of junk pipe.

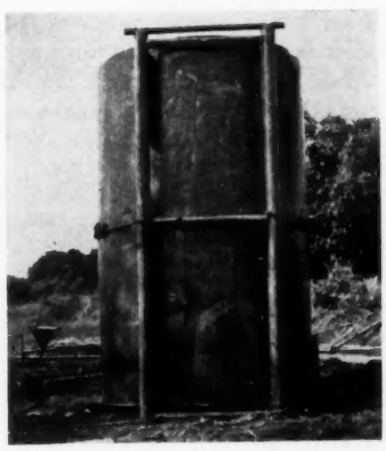
Tail Gate on Workover Unit Serves as Tool Compartment

Ordinarily, the tail gate on a truck-mounted workover rig serves little purpose. It holds the truck together and substitutes for a rear bumper. But one workover contractor welded a flat plate across the bottom portion of the pipe and provided his crew with an excellent compartment for storing cheaters, pipe tongs and long-handled tools as shown.

The advantage of the compartment is its location; it is handy to the crewmen, yet it is not in the way.

Steel Housing Protects Engine on Field Location

This Gulf Coast operator has installed a steel housing over the prime mover of this salt water disposal pump. The cover is equipped with hinged sides which can be raised to facilitate repair work. Sheet steel, angle iron and junk pipe are used to construct the cover. The engine thus is protected from weather, livestock, etc.



Speed Tank Handling With Hefty Skid

Weld a four-inch pipe skid to the side of a 100-barrel tank and speed its handling.

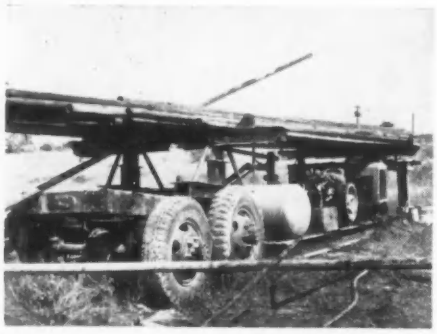
The speed of moving in and setting up—and tearing down and moving to

the next location—can spell the difference between profit and loss. Contractors are placing more and more equipment on wheels or skids. The skid on the tank shown here enables the contractor to move the tank about the job as fast as a gin-truck can pull it. At the same time the skid protects the tank during the rough treatment.

The skid is made of four-inch pipe as shown. It is attached to the tank with ¼-inch gusset plates welded to the tank beneath the four-inch runners. A belly-band of sucker rod and chain is clamped around the middle for additional strength. The valves are positioned for the upright position.

Skid-Mounted Gin Pole Used in Swampy Area

This skid mounted gin pole was designed for use in areas where access by road is difficult. In many cases, self-contained truck mounted units cannot be moved on location because of poor road conditions. The skid mounted unit and drawworks (not shown) may be pulled on location in two trips using a tractor.



Let Master Shaft Operate Drive Pumps or Generator

This utility trailer not only has a a rack for water piping on its top side, but underneath it has one engine that powers an "all-purpose" multi-sheave drive shaft which transmits power to a pump, generator or air compressor.

The sheaves are sized to provide proper speed and torque for the various driven units. Each end of the shaft is supported in pillar bearings. As the individual units are needed, they are hooked to the shaft with V-belts. When not in use, these belts are looped over the side of the trailer runner as shown in the foreground.

Small Chemical Lubricator Installed at Pump

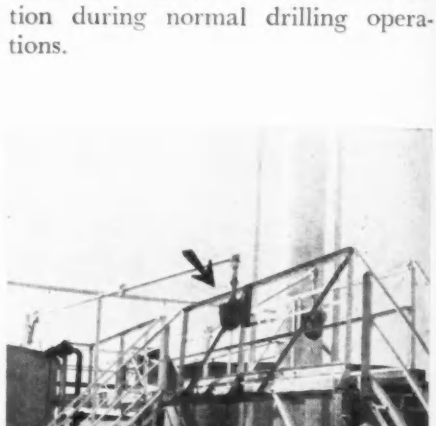
In many areas, high bottoms necessitate frequent rolling of tanks and it is usually necessary to inject emulsion breaker or to recirculate through a heater treater to obtain clean oil. Where possible, it is best to treat and roll the tanks through the heater and back through the tank. However, not all batteries have facilities for injecting chemicals. On many leases treatment occurs at the well head and batteries are not equipped to inject chemical into recirculated oil. This operator has made a small chemical lubricator from lease scrap materials and with the aid of two valves and a tee has a very effective lubricator for injecting emulsion breaker into the oil as it is being recirculated.

How to Keep Track Jacks Under Rig From Slipping

Weld short nipples of extra heavy 3-inch pipe to the top of a pair of track jacks and you have additional supports and ready leveling devices for a trailer-mounted drilling rig.

As shown here, one contractor modified the jacks in this manner, fitted the 3-inch nipples over 2½-inch lifting lugs to come up with a means of leveling the rig even during the drilling operation. In addition, the jacks help support the rig.

The nipples eliminate the possibility of the jacks slipping out from under the load as the result of vibration during normal drilling operations.



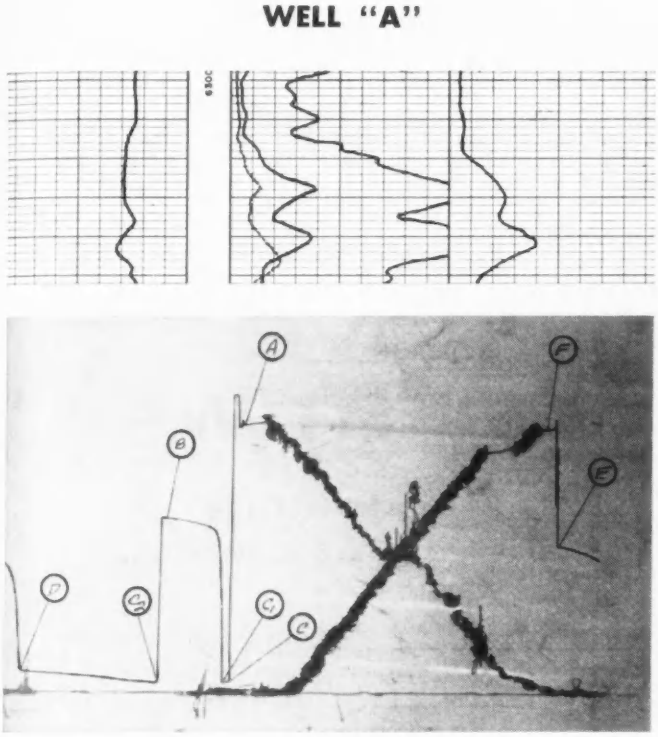
Remote Opening of Hatch Cuts Poisonous Gas Hazard

Equipping stock tanks with remote gaging equipment in sour crude producing areas reduces hazards to pumpers and gagers. As a further safeguard one company provides a simple means of enabling personnel to open the gage hatch from a distance of 20 feet or more.

A light cord is attached to the hatch cover and brought up over a small sheave fastened to an overhead gas line. It then is brought over to a point beside the hand rail where the pumper can reach it as soon as he gets to the top of the ladder. Opening the hatch from a distance permits safe release of the initial puff of gas that has accumulated in the tank. It reduces the possibility, even though remote, of a man being overcome should his mask equipment be faulty or incorrectly placed over his face.

WHICH WELL WAS THE PRODUCER?

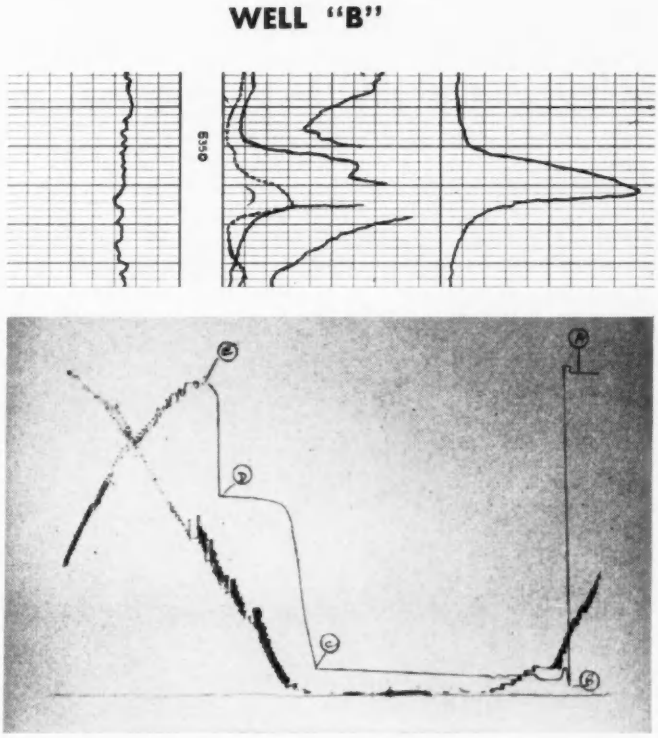
WELL "A"



Electric logs on well "A" indicated fair to good permeability. Resistivity was indicative of fluid content. Cuttings showed a good oil stain on the interval 6312—6357. Core analysis and log interpretation left considerable doubt as to whether the zone would be commercially productive. The section showed a good percentage of porosity, fair permeability and 10.6% oil/46.5% water content. To supplement existing data, Johnston Testers performed a three-hour Selective Zone Test on the sand and recovered 125 feet of oil and 700 feet of water.

Casing was set on the well and the zone perforated. The sand was acidized to stimulate production and improve oil/water ratio. Was this well a commercial producer?

WELL "B"



A slight oil show was noticed in cuttings from the sand at interval 5350—5370 shown on the above log. Logs which were run indicated low permeability at this interval. Core analysis verified the low permeability but showed a rather high percentage of porosity and 18.2% oil/36.5% water content. To supplement this data, Johnston Testers performed a four-hour Selective Zone Test and recovered 370 feet of oil and 180 feet of gas cut mud and water.

Casing was set and the zone perforated. The sand was treated to improve the flow characteristics and improve the oil/water ratio. Was this well a commercial producer?

Above Drill Stem Test information, test data and the fluid recovery, indicated a non-commercial producer on Well "A." Subsequent acidizing result was poor. The well was abandoned and plugged.

Drill Stem Test information indicated commercial production from Well "B." Well "B" became the producer, flowing in excess of 150 bopd.

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Diamond Chemicals

Engineer-type licensing won't help geologists

Upgrading of geological profession must come from within. Reorganization of AGI may help

By **Roy H. Guess,** Geologist
Newman Brothers Drilling Co., San Antonio

UNTIL A FEW YEARS AGO no serious study had been given to the possibility of state or federal registration of petroleum geologists. There was little or no demand for such control since the oil business was booming. Geologists were in great demand but in short supply. Today the supply is ample but the demand for geologists has been steadily declining.

Under existing circumstances does the geological profession need, or would it benefit from some type of state or federal registration or licensing? Engineers, doctors, lawyers and architects are subject to various state registration laws designed primarily for protection of the public. Could geologists improve the profession by following this lead?

Registration would not help large oil companies because they thoroughly investigate the educational background of every employe and then spend considerable time training personnel for the job at hand. The problem exists primarily between independent geologists and the public. The independent geologist needs some convenient means of proving conclusively that he is thoroughly qualified, fully trained and completely ethical. The general public may need protection against charlatans and untrained or incompetent "geologists" and against competent but unscrupulous geologists.

During the past 20 years, no appreciable improvement in the professional standing of geologists, neither in the eyes of the business world nor of the general public has been evident to the author. This is true despite the fact that throughout this period there have been many fine, well-trained professional geologists. Worldwide achievement has been great, as shown by the worldwide superabundance of crude petroleum and natural gas. Obviously a public relations problem exists. Remedies for it should be commenced without delay.

At the invitation of WORLD OIL, the author has written this article on a highly controversial subject, expressing his own opinions based on many years of active oil and gas exploration work and a thorough background in petroleum geological association and committee activities.

One solution to this problem might be a state registration or licensing law. During a recent poll of over 800 geologists, the majority suggested that this idea be discarded. Some reasons given follow:

- Frequently, state or federal law which seems very desirable today becomes an abomination tomorrow
- Government regulation usually leads to confusion and expense
- The loss of freedom inherent in most government regulation far outweighs any possible good that might result
- State control would hamper the honest, conscientious geologist more than it would the charlatan, since the latter is accustomed to finding devious ways of accomplishing an objective
- Legislation cannot create ability, integrity or personal industry
- Geologists can regulate and control their own profession better than politicians
- A small minority of geologists could control state registration for their own personal aggrandizement
- This would be just another way for the government to collect taxes. At first payment would be in small fees, but later when state income taxes become general, each state in which a geologist registers would claim a tax is due from work performed in that state. Several states might claim a tax on the same work. What a mess that would be!
- Geology is a science, scarcely lending itself to licensing. The application of that science may be licensed, however
- Legislation can reward the incom-

petent more than it aids the competent

• Geologists range far and wide, crossing state lines indiscriminately. Geology does not conform to geographic boundaries. Imagine the chaotic situation that would exist in the Four Corners area with a different set of registration laws in Colorado, New Mexico, Utah and Arizona! Uniform state laws are an impossibility

• Human nature being what it is, the problem of charlatans will never be fully eliminated. A famous showman is widely quoted as describing this weakness ("a sucker is born every minute"), the popular impression being that he capitalized on it quite effectively. However, geologists need not place themselves, as a profession, in the charlatan category in spite of Mother Nature's success in putting some of them there.

The best solution to the problem, in the author's opinion, would be the creation of a national professional geological organization dedicated to the following precepts:

• Raising the standards of the profession through self-regulation

• Education of both industry and the general public to the fact that members have met the highest professional and ethical standards

About the Author

Roy H. Guess is geologist with Newman Brothers Drilling Co. in San Antonio, Texas, a position he has held for 13 years. A native of Beaumont, Texas, Guess was awarded his B.A. and M.S. degrees from The University of Texas in 1939 and 1940 respectively. Prior to joining Newman Brothers he was employed for eight years by Humble Oil & Refining Company, a period punctuated by World War II military service as a pilot in the Army Air Force. Among other geological association and committee activities, Guess is currently president of the South Texas Geological Society.

• National recognition of professionalism in geology to help stop erosion of geological functions by engineering registration laws.

Last year Warren Beebe and a committee composed of some of the most competent geologists in the United States worked diligently for many months and drafted a good plan for reorganization of the American Geological Institute along the lines just stated. This committee was hampered by the necessity of combining all earth sciences into one organization. This might be trying to go too far too fast. Petroleum geologists, in the author's opinion, should create the organization first, then perhaps broaden the base if it appears feasible to do so.

The basic problem is *not* "to register or not to register," but to make geologists realize that they have a definite responsibility to their profession and to the public. Effective professional reform must come from within.

The American Association of Petroleum Geologists is a scientific, not a professional, society. Its activities are legally restricted to the area of its stated objectives which are clearly defined in its constitution. Its tax-exempt status depends upon strict adherence to its stated purposes. Obviously, the AAPG cannot become a professional society without a complete reorganization.

There is a strong desire throughout the ranks of petroleum geologists to raise the scientific, academic, professional and ethical level of the geological profession. The AAPG is handling the scientific aspect very effectively. The academic segment of the geological profession has already realized that there is no reason for setting academic qualifications lower than those which are being forced upon the profession by general conditions. If past performance is any criterion, it won't take the colleges and universities long to tighten up standards. The logical conclusion is that geologists should take action immediately to improve effectively the two remaining aspects, i.e., professional and ethical.

A universally recognized group of professional geologists whose training, ability and ethics would be above question, should be the ultimate goal of petroleum geologists, regardless of how long it may take to achieve this goal. —**The End**

For better interpretation— let's get . . .

Back to the Rocks

THE CURRENT SQUEEZE on exploration appropriations has caused geologists and geophysicists to work even more diligently to upgrade their professional work. How are they doing it?—*by getting back to the rocks.* An intensive search, particularly for stratigraphic traps is under way. All geological and geophysical methods and tools are being used without excessive reliance on any one tool or technique.

Geologists are working not only with mechanical types of logs but with formation samples and microfossil data. Geophysicists are carefully determining anisotropic qualities of different formations and rock types and other velocity characteristics of different rock types and formations; and are trying to determine more exactly the effects of geological and astronomical factors on gravity and magnetic data.

Earth scientists are more concerned than ever with the influence of basement rocks and ancient mobile belts on sediments above, and are making greater efforts to reconstruct the sedimentary column as it actually developed (from the basement up) as contrasted to the opposite, though necessary approach of drilling a well (from the surface down). Basic studies of ancient climates are being made, based on reefs, evaporites, etc. to determine the warm water trends more conducive to prolific organic life and hence to formation of oil. These are but a few examples of the more basic approaches being made to oil-finding that lead oil-finders right back to the rocks from which oil and gas comes.

How to catch better rotary cuttings

Field-proven semi-automatic device yields clean, diagnostic samples, eases gathering problem

By Edward P. Roederer, Jr.
Paleontological Supervisor,
Phillips Petroleum Co.
Lafayette, La.
and **Harrison T. Brundage**
Exploration Editor, WORLD OIL

CLEAN SAMPLES, readily workable for paleontological analysis, can be obtained from rotary holes through the use of a new sample catcher and washer field-tested by Phillips Petroleum Company in southern and offshore Louisiana. The equipment operates very simply, has no moving parts, and requires virtually no maintenance. It requires a minimum of attention by drilling crews. Although so far this equipment has been used solely in sand-shale sections for paleontological analysis and is particularly useful in offshore work, it also is readily adaptable to collection of good samples for lithologic analysis.

Diagnostic offset tests. The sample catcher and washer, which has been under development since 1955, recently had a significant trial in two wells offsetting each other in Block 118, West Cameron (Louisiana) area, Gulf of Mexico. Phillips Petroleum Co. Redfish 1 had the benefit of this new equipment throughout the interval 4,490-9,730 feet. The sample catcher and washer was not installed on Phillips Redfish 2 until a depth of 6,200 feet had been reached. A greater number of individual foraminifera (approximately 135 percent more) were identifiable in the interval covered by the catcher compared to the

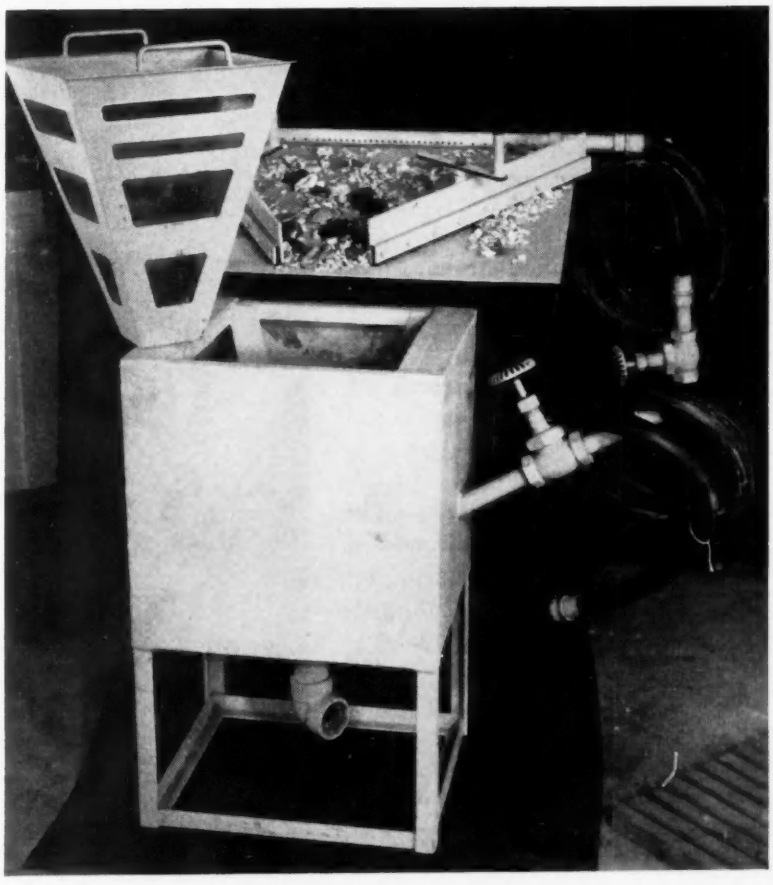


FIGURE 1—This photo was taken to demonstrate component parts of sample catcher and washer not actually in use. Cuttings are rotated off the shale shaker screen which in actual usage is located just above the collecting plate of this device. Wing nuts allow adjustment of collecting plate arms to provide as large or as small a sample as may be desired. Water washes down the collecting plate from perforated one-inch pipe. When inserted, the basket is placed in the washer with handles oriented at sides, with side toward foreground here (with unscreened top slit) at left and side toward background at right. Unscreened topmost slit on basket allows light lost circulation material to be floated off. Water entering the washer and basket at an angle under pressure via the lower (screened) basket openings cause the smaller cuttings and other heavy contaminants to be flushed out the bottom, leaving a clean sample of larger cuttings in the basket.

FIGURE 2—Handful of cuttings consists primarily of larger samples of shale. Sample is relatively free of drilling mud and other contaminants.

same section drilled without the use of the catcher. This was due primarily to the ability of the equipment to wash out unconsolidated, fine-grain and silty sands and to concentrate the large shale flakes containing the fossils.

Lost circulation material was used in both wells. Throughout the intervals in which lost circulation material was used, excellent samples were still obtained because of the ability of the device to float out most of the lost circulation material and still retain the heavier formation cuttings. Irrespective of how conscientious drilling crews may be in saving samples conventionally, many crucial sections are identifiable from guide fossils in samples caught by this equipment which are missing when conventional methods of catching rotary samples are used.

How the equipment works. The sample catcher automatically collects a representation of the entire formation being drilled. It continually washes drilling mud from samples so they are clean. Thoroughly mixed samples are acquired through use of this device. Since samples are normally sacked at 30-foot intervals, the thoroughly-mixed sample allows identification of key fossils since they often occur in very thin beds.

The catcher is designed so that most of the lost circulation material is floated out of the top of the basket and fine-grain, silty sands are flushed out via the bottom. This leaves a sample composed primarily of the larger, fossil-bearing shale cuttings. A smaller screen could be used in hard rock country if this device were adapted for lithologic sampling and analysis.

Cuttings are dropped from the flow line onto the shale shaker, and thence are vibrated onto the collecting plate (Figures 1 and 3). Cuttings are washed down the collecting plate by water from a perforated one-inch pipe welded to the top of the collecting plate. Water for this pipe is controlled by a gate valve.

The collecting plate is fitted with two volume control arms, each fitted with a wing nut. These arms are adjustable and control the volume of sample desired, depending on the drilling rate. The excess sample is diverted to either side of the washer and collecting basket.

The desired sample is washed through the arms by water from the perforated pipe and drops off the end of the plate into the collecting basket (Figures 1 and 3). This stainless steel basket fits snugly into the washing unit. It has stainless steel 20x20 mesh wire. The front and back sides of the basket are alike. The left side (looking toward the shale shaker) has an open slit near the top to permit lost circulation material to float out. This feature has proved extremely effective, resulting in much less contamination of samples than would be the case otherwise.

The right side has heavy bronze wire over the water intake opening to allow it to withstand the rapid flow of water and to permit large volumes to enter the basket.

The water intake of the basket fits exactly over the washer's water output, a one-inch pipe welded into the washing unit at a tangent. Water output is controlled by a gate valve.

Flow from the water output, usually at 60 to 90 psi pressure entering the basket's water intake, hits the bottom and opposite side of the lower portion of the basket at a tangent. This starts

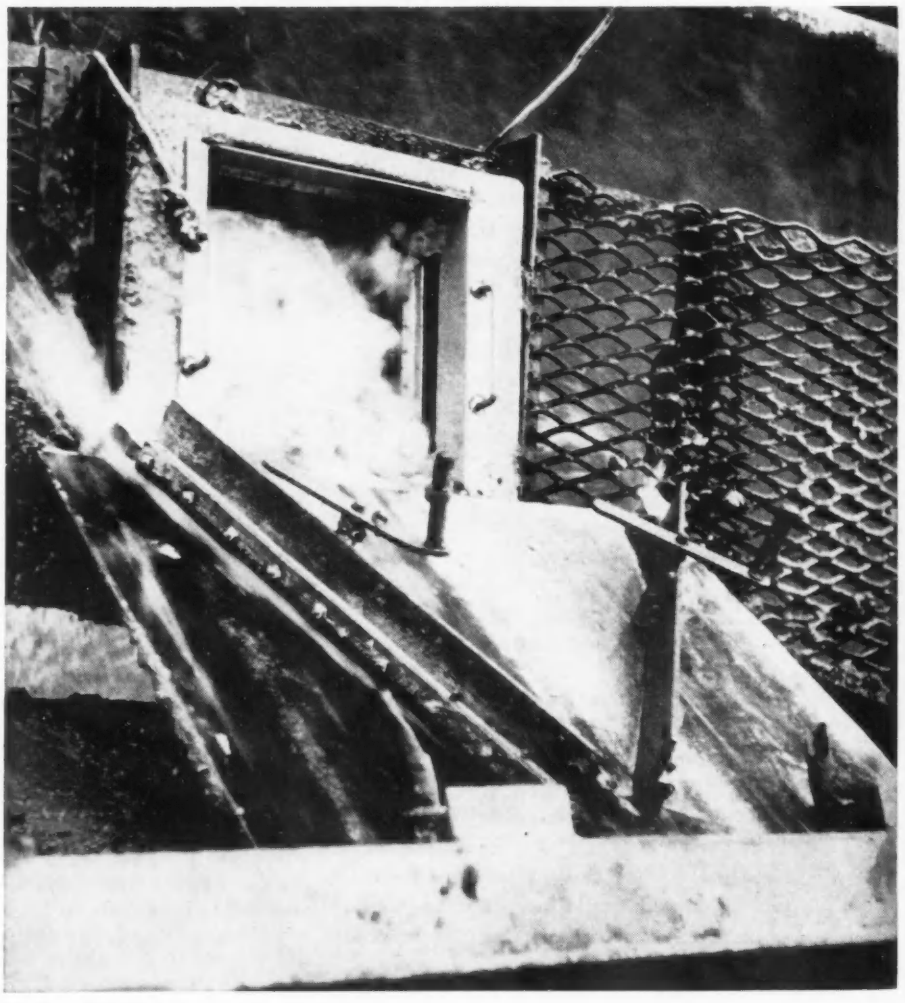


FIGURE 3—This photo shows sample catcher and washer installed downstream from shale shaker along a walkway on an offshore drilling rig. Here the arms of the tion material, like this froth, floats on the water and washes out of the basket via the excess being washed over the side. Notice the froth in the basket. Light lost circulation material, like this froth, floats on the water and is washed out of the basket via the unscreened top side slit (here visible at right side of basket since this view looks away from shale shaker).

a vortex motion which causes the sample to be mixed and washed thoroughly. Muddy water flows through the collecting basket screen and through the four windows in the washer. Waste water collects in the bottom of the washer and can be piped off through the two-inch opening there.

The one-inch hole in the center of the basket holder of the washer helps keep the washer clean to insure a snug fit for the basket. It helps remove silty and fine-grained sands. *This hole is threaded and can be plugged if a sample is desired for lithologic examination.*

After the desired portion of formation cuttings has been collected (usually coincident with each 30-foot single of drill pipe), the basket is pulled from the washer and replaced by another. A sample sack is filled, labeled as to well name and depth interval, and is hung in a sheltered place to dry. Then the basket is cleaned out.

The unit is equipped with two collecting baskets so a clean one may be inserted immediately to assure continuous sampling. This minimizes or eliminates contamination of samples from previously drilled formations.

Advantages. Use of this device tends to eliminate the loss of geological information automatically jettisoned with uncaught or improperly caught and/or mislabeled samples. Paleontologic and lithologic studies give much greater meaning to mechanical logs, and further develop interpretative techniques. The industry will search continuously for new and thinner pay zones, including some profitable ones which do not show up in electrical logs owing to poor resistivity and spontaneous potential characteristics in featureless ("railroad track") zones. It will become more important to acquire good samples from rotary well cuttings.

Some of the offshore drilling rigs were not designed for properly and conveniently caught samples. Many of these rigs have either a metal chute or a huge funnel—nothing to catch the cuttings that are vibrated off the end of the shale shaker.

In either situation, most or all of the cuttings are dumped into the water and lost. It is a near impossibility to collect representative cuttings via makeshift methods under such circumstances. The subject device, when properly installed and used, will insure that a representative sample of formations drilled will be available and conveniently collected.

The importance of the best samples obtainable cannot be stressed enough. In the U.S. Gulf Coast, micropaleontology, when properly utilized, establishes formation tops; helps electrical log correlations; helps prevent blowouts by establishing identity of formations above suspected high-pressure zones; helps determine faulting; identifies possible stratigraphic traps; helps prevent sticking of drill pipe; and recognizes updip limits of producing trends, among other vital stratigraphic objectives.

Limitations and cost. Regarding oil shows, oil in permeable rock cuttings is apt to be flushed out; however, this is true also of conventionally caught samples. Shows may still be determined in tight sandstone cuttings despite the thorough washing done by this equipment.

The initial cost of the equipment is approximately $1,000; installation costs are negligible. Although this equipment seems primarily of benefit to producing companies, many drilling contractors may find it worthwhile since it eliminates a number of steps often considered as a nuisance by drilling crews. Value of this equipment from the contractors' viewpoint may grow as oil companies become continually more insistent on making collection of good samples an integral part of the drilling contract.

The main limitation of the equipment is that it is not fully automatic. It requires the attention of a crew member occasionally to adjust the volume control arms, remove the basket, replace it with a clean one, fill and label the sack and hang it in a sheltered place to dry, and to clean the basket just used. However, this is an improvement over older procedures previously accepted by most paleontologists and stratigraphers in the U.S. Gulf Coast area. Such procedures are described as follows:[1]

A wide board should be placed beneath the end of the shaker where the cuttings drop. When the required interval has been attained, samples may be scooped off with a shovel. Cuttings should then be placed in a box with an area of one to one and a half square feet. The bottom of this box should be screen.

After samples have been placed in the box, run water over them with a hose, occasionally stirring cuttings with one hand until all sand and soluble material have been removed. This washing must be done while samples are wet. Once the shale dries out, it begins to disintegrate when wet again and microfossils pass through the screen. If cuttings are not washed and stirred sufficiently and sand is retained in the sample, it will usually result in a voluminous sample. The fossils are in the shales.

Rather elaborate instructions were also given[1] for floating out lost circulation material by stirring the cuttings in a five-gallon bucket while flooding the bucket with a hose.

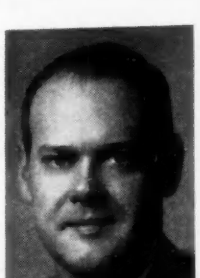
One feature of these older procedures is apparently timeless, however, and just as up-to-date as ever—*pick up samples at the rig often.* Crews, seeing large amounts accumulating, feel that the samples are of no value and become careless in catching them.

Since competition is greater than ever before, and the never-ending need to lower oil finding costs is more vital than ever, producing companies need to take the maximum advantage of all available geological tools. Certainly, basic sedimentary analysis is still one of the cheapest and most conclusive methods of finding hydrocarbons.

LITERATURE CITED

[1] "Technique of catching and handling well samples," SEPM instructions.

About The Author



Edward P. Roederer, Jr., is paleontological supervisor, Phillips Petroleum Co. in the Lafayette, La., field office. A native of Lexington, Ky., he received his B.S. degree in 1949 from the University of Kentucky, where he did additional graduate studies before joining Phillips in 1950 in Houston. Roederer served for one year as a subsurface geologist before entering paleontologic work, which he has done since. In 1955 he was transferred to Lafayette, where he is currently engaged in paleo work on Eocene and younger formations, both onshore and offshore.

Facies studies can reconstruct oil-forming environments

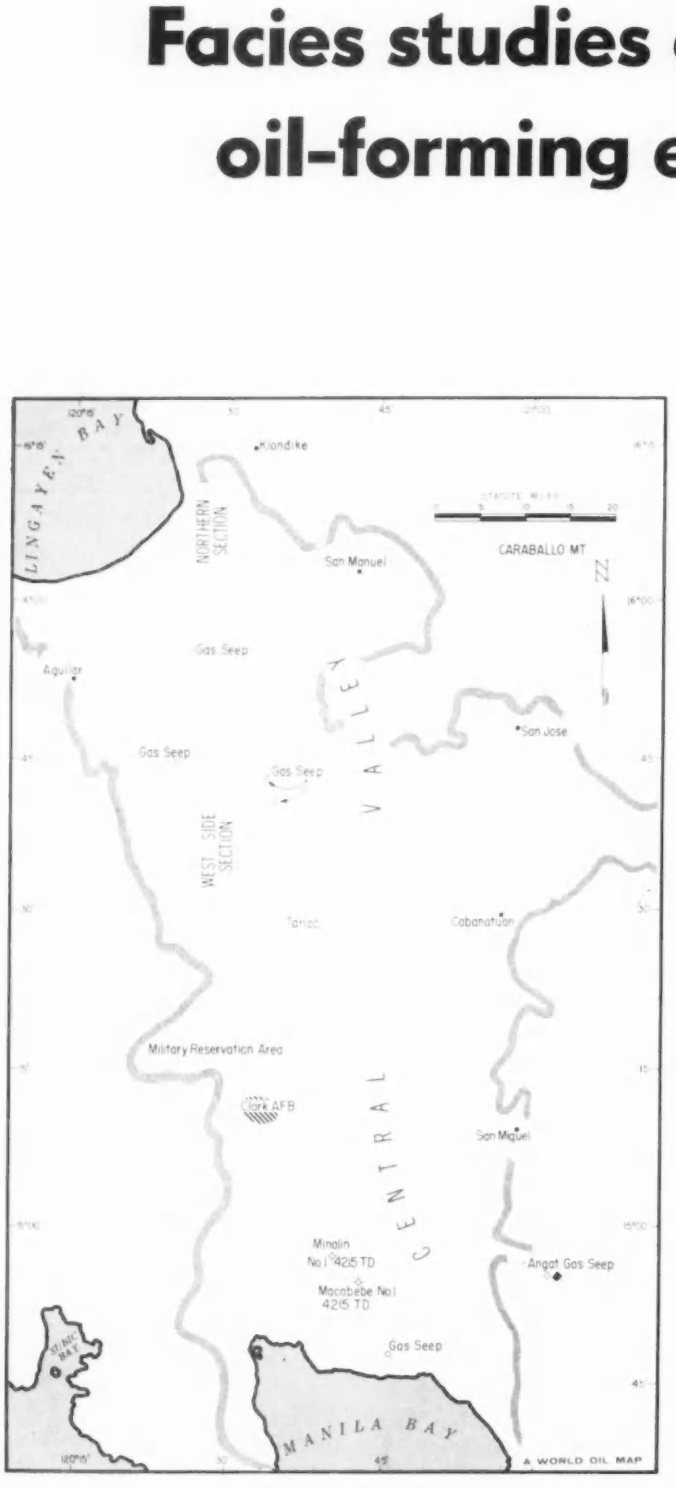


FIGURE 1—This map shows the general outline of the Central Valley of Luzon in the Philippines, where a detailed geological survey was made. Emphasis was on depositional environment reconstruction through micropaleontologic studies.

Shallow and deep-water types of foraminifera help determine source and reservoir rocks, faults, stratigraphic traps, depositional history

By Orville L. Bandy, Professor of Geology
University of Southern California
Los Angeles

MODERN STUDIES of marine geology and faunal assemblages of the sea floor are rapidly expanding knowledge of present ocean basins and varying depositional conditions. Sands are now known to be deposited not only on inner shelf and on platform areas, but also in deeper waters via such transporting mechanisms as turbidity currents and submarine slumping.

Such diverse depositional environments result in sand bodies of varying character, especially as to shape, distribution pattern, and permeability. Thus, it is important to determine the environments of deposition of sand bodies that are likely reservoir beds for petroleum. One of the best methods of reconstructing paleoenvironments is by use of fossil foraminifera.

Foraminifera are marine protozoans, generally characterized by a small shell of some kind and thread-like pseudopodia. Most smaller types range in size from about 0.2 mm to more than 1.0 mm, although both smaller and larger ones are known. In modern analyses, it is customary to differentiate between floaters in surface waters (planktonic types) and those living on the sea floor (benthonic types). With death, floaters may rain down on the sea floor in very diverse environments,

providing a primary tool for stratigraphic correlation. Evolutionary and population changes are recorded simultaneously in a variety of depositional environments.

Bottom dwelling types, on the other hand, reflect the bottom environment in which they live. They are one of the most abundantly occurring groups of organisms that leave a fossil record. Faunas are very diversified. Some live in brackish waters, some in nearshore sediments of the open ocean, others on the outer continental shelf, and still other groups in progressively deeper zones.

Fossil foraminifera are abundant in marine sedimentary rocks of most oil-producing areas, thus providing a means of evaluating depositional environments by analysis of bottom-dwelling types and comparing these with modern assemblages. Some methods of using fossil foraminifera to reconstruct past geologic environments are summarized here.

Environmental logging. One useful application of paleoenvironment analyses is in environmental logging of sections and wells. Advantages of this type of analysis are shown by some generalized geologic illustrations from the surface exploration program of the San Jose Oil Company, Inc., in the Central Valley area of Luzon, Philippines (Figure 1). Exploration of any new area requires understanding of the distribution characteristics of reservoir and source beds in time and space, and the solution of structural problems involving these beds.

In surface work, it is important to envisage the environmental framework of the depositional basin involved. This cannot be done satisfactorily with a single type section which will represent only the stratigraphic and environmental history in one area of the former marine basin. Single type sections have been useful in dealing with the relatively widespread, uniform sediment blankets of former platforms. However, rapid facies changes are encountered away from platform areas in basinal and geosynclinal regions.

Detecting faults by environmental analyses. In one of the surface sections in the northern area of Central Valley, Luzon (Figures 1, 2), a plot is made of water depths indicated by the faunal assemblages in a continuously collected section. The lower two-thirds of the section is made up of shales, mudstones and siltstones. The upper third is mostly sandstone and conglomerate.

Ordinary paleontological analyses indicate the basal portion to be late Miocene and the remainder of the section to be Pliocene and Pleistocene in age. Environmental analyses add materially to the understanding of this section by showing deeper water facies in the basal beds here and then an *abrupt break* above which only inner shelf or paralic facies are represented.

Thus, within the uniform lithologic sequence appears an important stratigraphic break pin-pointed by environmental analyses. The break is not readily detected in surface work because of the relatively massive nature of the strata.

Foraminiferal species serving as deep water indicators in this section include *Pullenia bulloides* (d'Orbigny), *Laticarinina pauperata* (Parker and Jones), and *Osangularia bengalensis* (Schwager). Modern representatives

Surface Section in Northern Part of Central Valley, Luzon

(Adapted From Sections By San Jose Oil Company, Inc.)

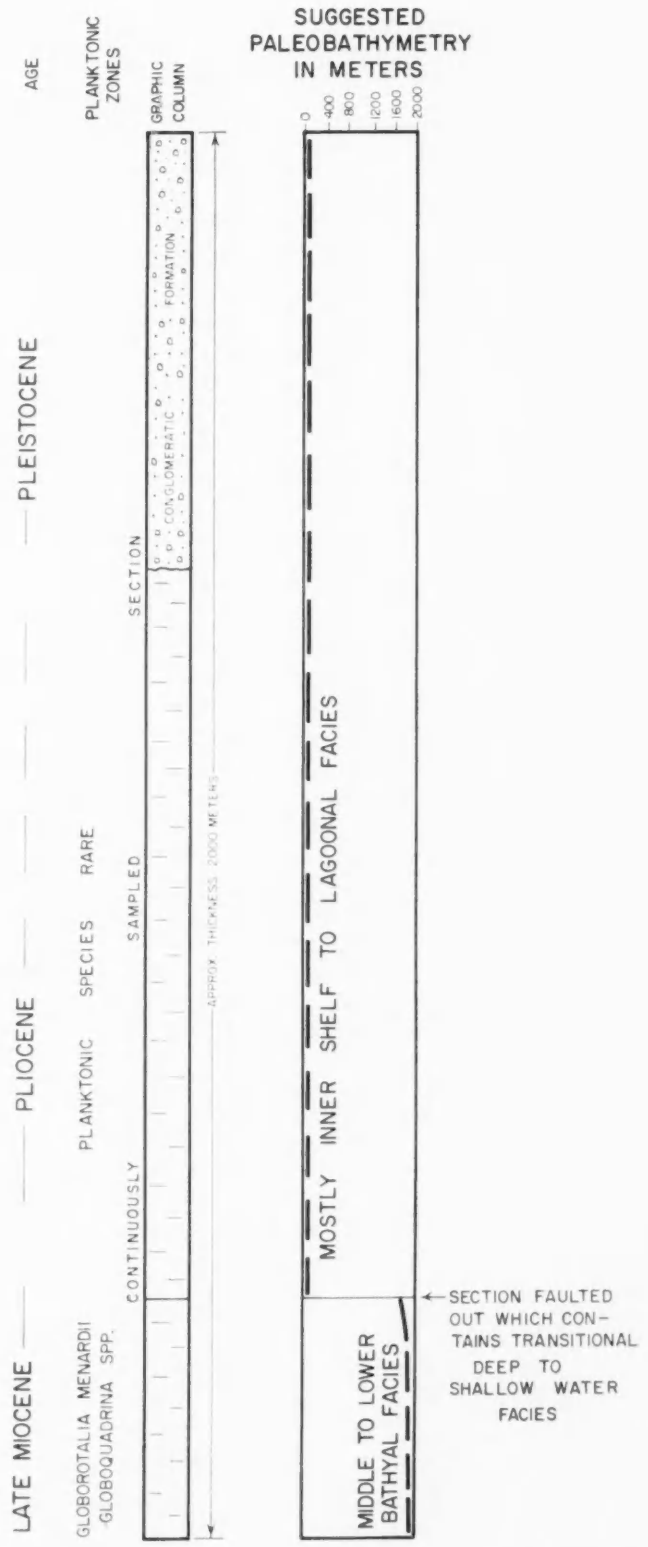


FIGURE 2—Measured section covering part of the northern side of the Central Valley of Luzon was examined for environmental trends based on foraminiferal assemblages. Abrupt faunal change is interpreted as a fault.

Composite Surface Section In Western Part of Central Valley, Luzon

(Adapted From Sections By San Jose Oil Company, Inc.)

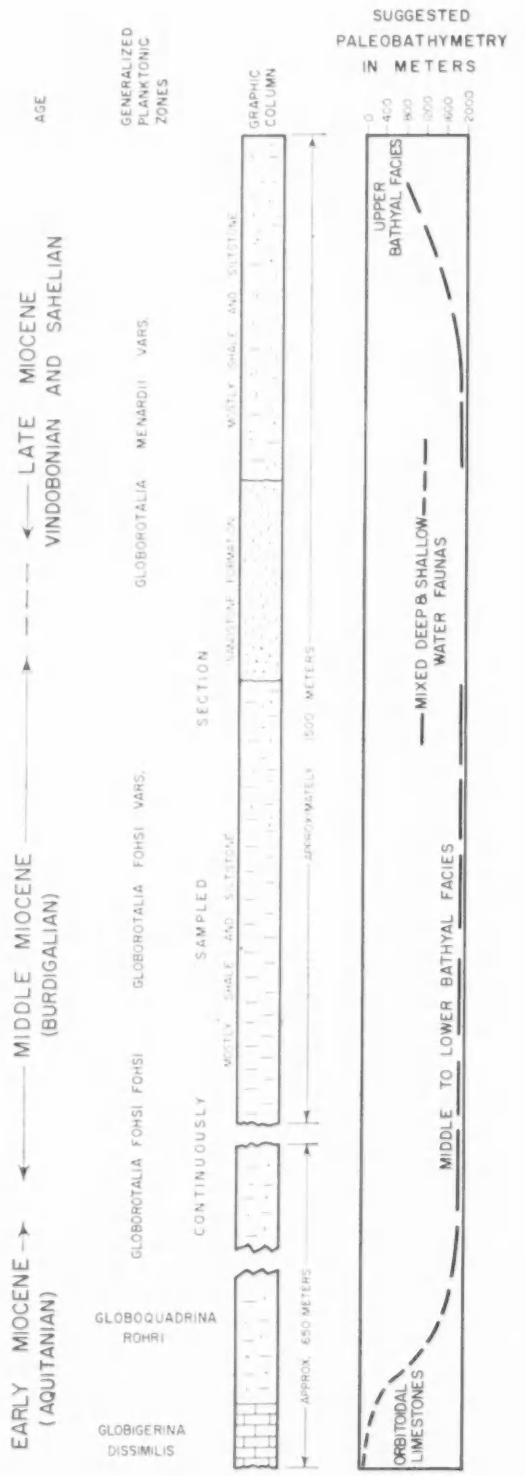


FIGURE 3—Deeper water fauna appear to be more diagnostic of environmental trends indicated by forminiferal assemblages in a measured section covering part of the western side of the Central Valley of Luzon.

of these are inhabitants of marine waters usually deeper than 6,500 feet.

Shallow inshore facies, on the other hand, include mainly an assemblage of *Streblus* and *Elphidium,* modern representatives of which occur usually in inshore waters, bays, and lagoons. Thus, the important transitional facies between these two extremes are missing and are evidently faulted out of this particular section, although they may occur in other sections. Age determination or stratigraphic correlation was based primarily upon planktonic species of foraminifera in the Miocene portion of the section.

Environmental conditions of possible reservoir beds. One of the most important requisites of valid and useful environmental analysis is that of proper control. Modern studies of the oceans often reveal introduction of sands into deeper waters, producing curious mixtures of deep and shallow water faunal assemblages. The specialist on shelf type fauna (e.g., many molluscan assemblages and orbitoidal types of foraminifera) is apt to interpret deposition in this case as occurring in shallow water, whereas the specialist on smaller benthonic foraminifera would most likely assign the assemblages to a deep water environment.

Samples of a stratigraphic section collected at random may be easily out of context, so to speak, and provide confusingly different environmental concepts. Continuously collected sections will usually clarify such problems.

Coarse sediments of the Pliocene-Pleistocene at the north end of the Central Valley of Luzon exhibit almost entirely the *Streblus-Elphidium* assemblage of the inner shelf or paralic type of facies (Figure 2), providing a relatively straightforward environmental picture there. Sandstones and coarser clastics occur in other parts of the stratigraphic section. This might not be so easily understood.

One example from the western side of Central Valley of Luzon will serve to illustrate the problems of deeper water coarse clastics (Figure 3). This section on the west side of the valley is composed of a basal limestone followed by fine clastics, a prominent sandstone formation, and then another series of fine clastics at the top of the section. The basal beds contain orbitoidal foraminifera and other shelf types which are of early Miocene age (Aquitanian), as determined by planktonic foraminifera. These basal beds give way to deeper water conditions that continue throughout the sampled section. The problem arises as to the conditions of deposition of the sand body in the section. One would normally interpret this as a shelf sand; however, deep water species of foraminifera occur in the section below the sandstone, in the basal portion of the sandstone, and again immediately above it. Some of the deep water species are *Pullenia bulloides* and *Osangularia bengalensis.* These species today are characteristics of water depths of more than 6,500 feet in the Gulf of California and similar and greater depths off the coast of Central and North America.[1] Associated with the section below the sandstone are some shelf assemblages mixed with the deeper water facies.

It seems reasonable to interpret conditions of deposition as being defined by the deep water species and to

consider the shelf types as having been carried in by submarine landslides and turbidity currents. This means the sands of this part of the section were brought into a deeper part of the basin by the same types of transporting methods. The distribution pattern of such sand bodies is likely to exhibit fairly rapid changes in thickness and to lense out along the strike of the beds.

It is noteworthy that even though such sand beds may pinch out, displaced foraminifera of shelf assemblages may be present at the same general horizon. Analysis of assemblages along strike and approaching such lenticular features may help establish criteria for predicting proximity to such features. Correlation of the stratigraphic section is again based primarily upon planktonic species of foraminifera.

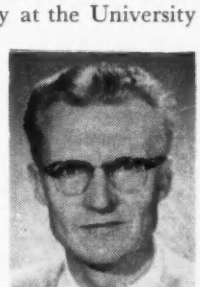
Paleoenvironmental analyses in exploration programs. Recorded in such a section (Figure 3) is the environmental story of basinal development for one portion of the middle Tertiary seaway of the region. Attention to the environmental significance of faunal assemblages suggests a number of factors of major importance in implementing an exploration program. First, the marine transgression represented by the basal part of the section was associated with prominent subsidence, a condition in which subsidence of the basin floor was far greater than the rate of deposition, thus resulting in progressively deeper water. Second, deep water conditions continued for most of the Miocene as represented in this section, indicating that reservoir beds of this portion of it should be evaluated in terms of this type of environment. Coarse basin deposits resulting from submarine slumping or turbidity currents could represent either subsea fans or turbidity current deposits (turbidites) in pockets (closed basins) on the sea floor.

A third crucial factor indicated by the rather long continued cycle of deep water conditions in a section (e.g., Figure 3) is the problem of determining the areal extent of such a basinal development cycle and the correlation of possible facies boundary trends with other geologic evidences of structural involvement. Subsiding areas are separated from the surrounding sea floor by structural trends. Modern examples of facies-structural relationships are well illustrated in the Gulf of California today[1] and in the continental borderland off southern California. Facies determination of progressive tectonism during deposition of Tertiary sediments is well illustrated in the recent study of the San Joaquin basin of California.

The question arises, are shelf sands or basin sands most favorable as reservoir objectives? Sufficient evidence has accumulated to show quite definitely that deep water types of foraminifera are associated with the reservoir beds of many oil-producing areas such as almost the entire Los Angeles Basin of California (Pliocene and Miocene), the middle Tertiary of the San Joaquin Valley, and in numerous other examples. Conversely, shelf deposits, and especially the transition from shelf to continental slope have proved to be of primary importance in many parts of the world. Thus, it is not desirable to categorize one type of facies as being more favorable than another based merely upon environment, but to evaluate the objectives in terms of source bed proximity, porosity and permeability characteristics and trends, and other geologic characteristics.

About the Author

Dr. Orville L. Bandy is a consultant for several oil companies and is professor of geology at the University of Southern California, Los Angeles. His experience in oil exploration in recent years includes work in southern Asia, the Philippines, Central America and North Africa. Bandy obtained B.S. and M.S. degrees in geology at Oregon State College in 1940 and 1941, respectively. From 1942 to 1946, he was a communications officer with the U.S. Army Air Corps. In 1948, he received his doctorate at Indiana University and has since been on the geology staff of U.S.C.



ACKNOWLEDGMENT

The author wishes to thank the geological staff of the San José Oil Company, Inc. and James L. Buckley, president of San José Petroleum, Inc., for releasing geological data on the Philippines used in this article.

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Sequence shooting boosts signal-to-noise ratio

THE DEVELOPMENT OF VELOCITY LOGGING of shot holes (WORLD OIL, October 1960, pp. 160-168) has a sequel in current research with multiple sequential seismic shooting to increase the signal-to-noise ratio. Two (or possibly more) charges are loaded into shot holes at known vertical distances from each other and detonated in sequence. Timing of shots is in accordance with measured velocities in the holes, so that impulses are projected downward in phase instead of interfering with each other. This seismic "one-two punch" is being developed particularly to eliminate "ghost" energy which may be relatively so weak under this arrangement that it may readily be filtered out. Field experiments to perfect such systems are continuing.

How closely is U.S. wildcat drilling controlled by seismograph?

THE ACCOMPANYING FIGURE shows two curves of exploratory activity. One is a history of wildcat drilling in the United States from 1937 to 1959. The other is a similar history of seismograph crew-months. They show a very high degree of correlation.

At first glance this is not surprising. Both are facets of exploration. Both are subject to the supply of capital, the demand for crude, and the other factors which give the oil business its ups and downs. So they should correlate.

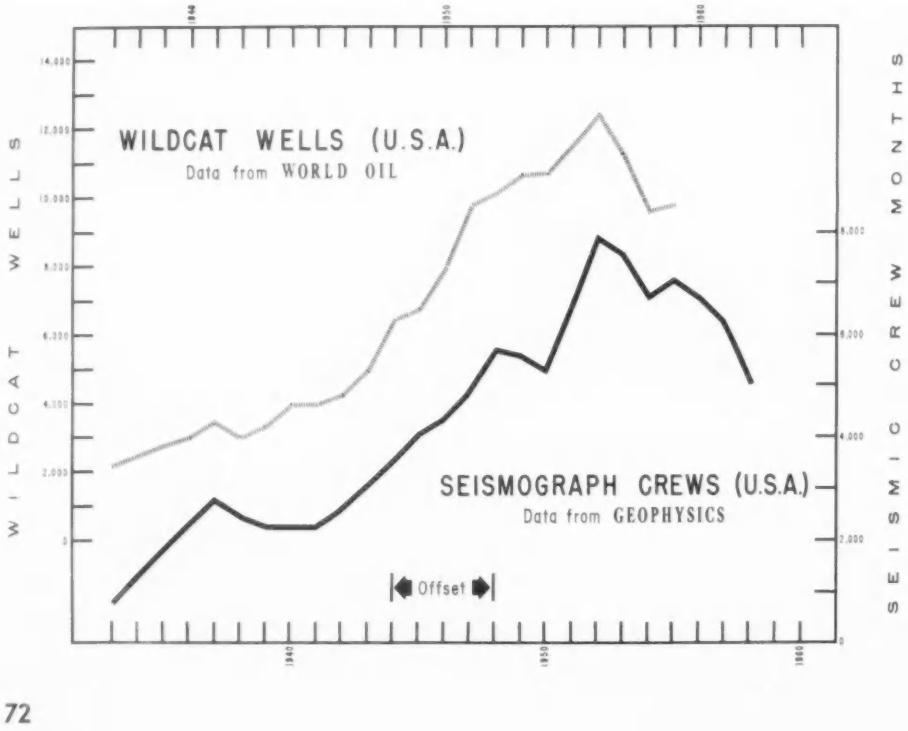
But take another look. The two curves have different time scales. The bottom curve is offset four years to the right, so that wildcat drilling in 1940, for example, is plotted above seismic work in 1936. Obviously if this four-year offset were removed, there would be no correlation.

What, then, does the correlation of the two curves mean? Certainly both cannot be controlled by the supply of capital, the demand for crude, and other factors which determine the state of the industry at any given time. It is strongly apparent that the number of wildcat wells drilled in any year is greatly influenced by the amount of seismograph work done *four years previously.*

These curves suggest that the number of wildcat wells drilled in 1965 may depend, not on the wildcat drilling budget for that year but on the *seismograph* budget for 1961.

In recent years, seismograph activity in the United States increased slightly in 1955, declined from 1955 through 1958, and increased slightly to 5,097 crew-months in 1959, up 0.65 percent from the 5,064 crew-months in 1958. According to the SEG Committee on Geophysical Activity, total seismic party months in the U.S. dropped again in 1960 to 4,625, a decline of 9.3 percent from 1959. Hence, if seismic work controls U.S. wildcatting as closely in the future as in the past, exploratory well totals should decline in 1961 and 1962, increasing slightly in 1963, and declining again in 1964.

Wildcats completed in the U.S. totaled 9,799 in 1958; 9,940 in 1959; and 9,103 in 1960. WORLD OIL has predicted completion of 8,917 wildcats in 1961 (February 15, 1961, Page 98). If borne out, this will represent a 2.1 percent drop from 1960. Geologists in the United States whose opinions were requested for the "Exploration Outlook 1961" feature (WORLD OIL, February 15, 1961, pp. 87-97) were generally less optimistic about the wildcatting outlook than a year before.



Effect of new methods? However, at long last it appears that a direct exploratory method of finding oil and gas is being developed (WORLD OIL, March 1961, pp. 54-57). If the radio reflection method is as effective as field tests to date on the Texas Gulf Coast indicate, the long-standing correlation between reflection seismograph activity and U.S. wildcat totals four years later may no longer hold.

Although U.S. wildcatting may continue to drop, exploration procedures *are* improving. A higher proportion of wildcats drilled should be completed as producers in the future. Although gross wildcatting statistics may appear to suffer somewhat, a lower proportion of dry holes will mean a more effective, more healthy industry. **—The End**

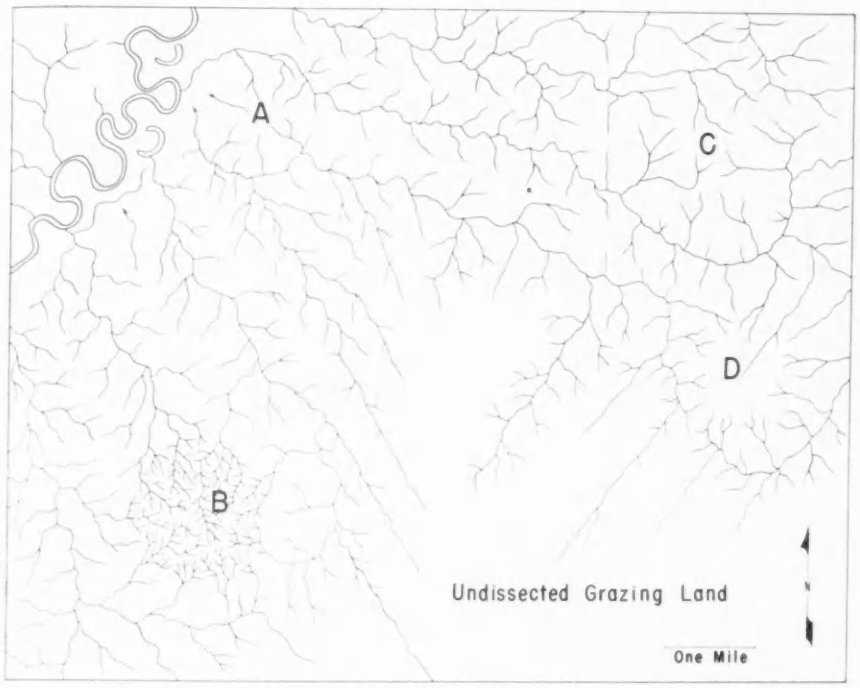


FIGURE 1—Analysis of stream drainage patterns indicates four anomalous areas. Without consideration of other photogeologic criteria, some negative anomalies might be drilled, or subjected to relatively expensive follow-up geophysical work, some of which would have proved needless.

Photogeologic leads can be deceptive

Check drainage anomalies against other photogeologic data; buried strat traps suggested

By Victor C. Miller, President
Miller and Associates, Inc., Denver

INCREASED USE OF AERIAL PHOTOGRAPHS is an apparent trend in oil exploration today, even in low-relief areas. Stream drainage patterns can be handy clues to oil-bearing subsurface anomalies, but stream patterns alone are unreliable.

Study of the various land forms sculptured by surface agencies (geomorphology) has long been a geologic specialty. Adaptation of aerial photography to this specialty has enhanced oil exploration efficiency, allowing rapid reconnaissance of large areas, and providing prior guidance to geophysical surveys to such an extent that such guidance may completely defray the cost of the adaptation.

There is little, if anything, involved in this low-cost work that cannot be readily comprehended by non-geologists. It is especially applicable to the search for petroleum in low-dip, frequently mantle-covered basins, plains and coastal areas. In disturbed areas of extensive outcrops, standard photogeologic mapping programs can be undertaken.

In a rapid regional reconnaissance, two-dimentional mosaic studies frequently disclose numerous drainage pattern anomalies, sometimes indicative of gentle, underlying oil and gas-producing structures. Unfortunately, however, many promising-appearing drainage anomalies have non-structural explanations. Pattern alone is unreliable. In addition, many significant structural, tectonic, epeirogenic and lithologic elements may be expressed in the topography, though they do not produce mappable two-dimensional drainage anomalies.

Comprehensive analysis of terrain in three dimensions makes it possible to reevaluate oil possibilities in the deeper, more central parts of intermontane basins. The technique also invites regional studies of vast glaciated plains (i.e., Canada, Alaska, Williston Basin). It permits another look at areas such as the Denver-Julesburg Basin, Las Animas Arch and the Nemaha Ridge. It suggests a second look, photogeologically speaking, at the Gulf Coast and the Mississippi Delta.

Few parts of the United States have not been mapped at least once by standard photogeology or by routine two-dimensional drainage studies. Competition now demands thorough analysis and interpretation. The operator using three-dimensional photogeomorphic analysis will discover not only the more obvious features (probably already found and investigated by others), but will also detect structural and stratigraphic conditions which are reflected by anomalous stream entrenchment, unusual variations in stream regimen, anomalous drainage density, flood plain changes (i.e., widenings or restrictions), unusual distributary characteristics, terrace or pediment tilting and fault displacements.

Few, if any, of the geologically-significant features detectable by such studies can be discovered by standard field methods, on mosaics, or on photo-indexes.

Characteristic drainage anomalies. Some three-dimensional terrain analysis principles may be illustrated with sketches. Figure 1 is a drainage map similar to one obtainable by tracing streams from a single mosaic or a clear photo-index. Four anomalies (A, B, C and D) are designated. Their selection is made after consideration of the regional drainage system and pattern. No other interpretation criteria are possible in this case. Linear streams suggest a well-developed system of northwest and

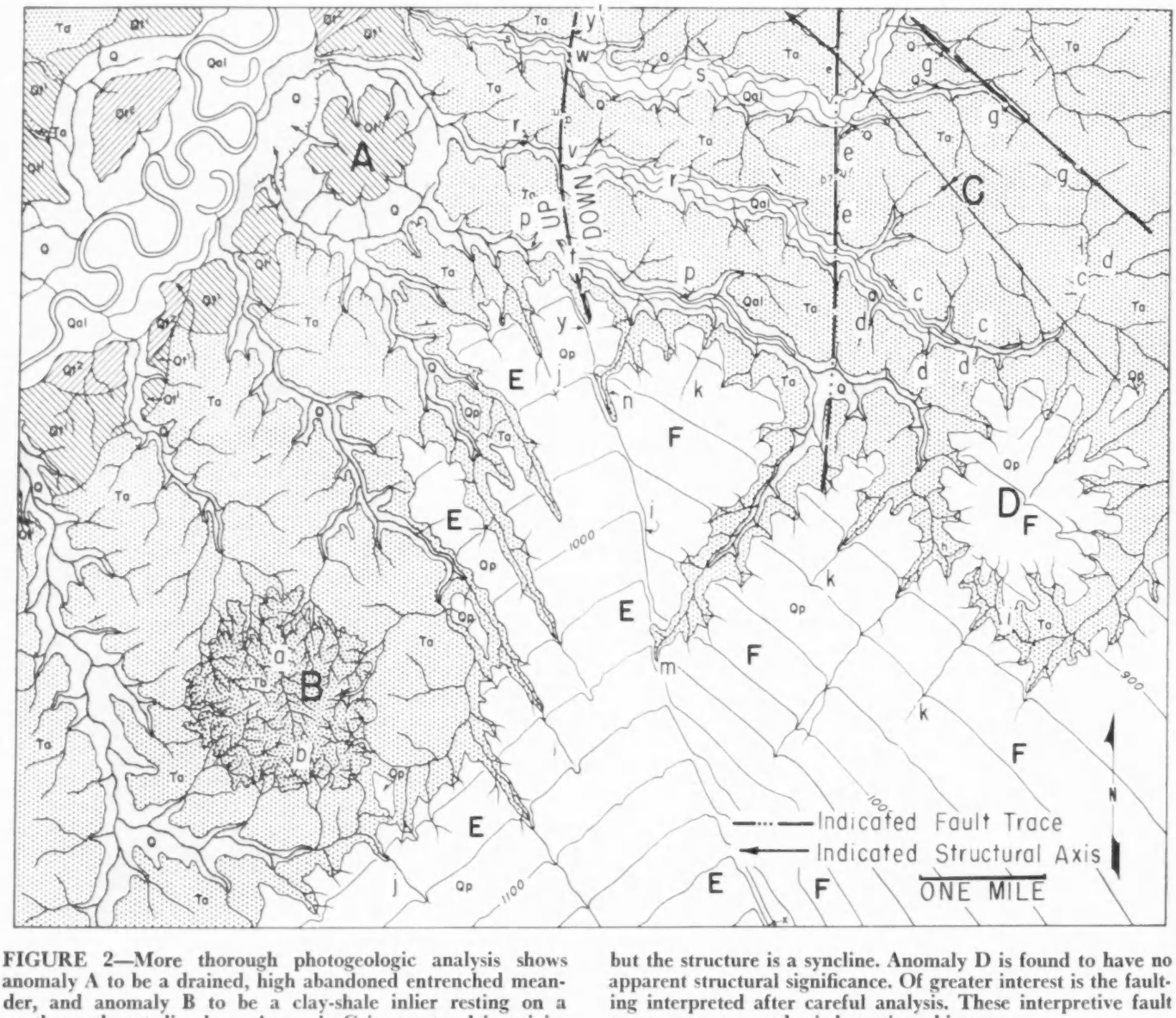


FIGURE 2—More thorough photogeologic analysis shows anomaly A to be a drained, high abandoned entrenched meander, and anomaly B to be a clay-shale inlier resting on a gentle northwest dip slope. Anomaly C is structural in origin, but the structure is a syncline. Anomaly D is found to have no apparent structural significance. Of greater interest is the faulting interpreted after careful analysis. These interpretive fault traces may suggest buried stratigraphic traps.

northeast- trending fractures or faults throughout much of the area. The four anomalies suggest local structural highs.

- Anomaly A displays annular and radial drainage.
- Anomaly B displays radial and a crude annular drainage, as well as a noticeably high drainage density.
- Anomaly C displays annular and radial drainage.
- Anomaly D displays radial and poor annular drainage.

Detailed stereoscopic analysis of aerial photographs of the area has permitted mapping of numerous unconsolidated rock units, and detection of gentle dip in a few places where the structure of mantled bedrock is reflected on the surface (Figure 2).

Anomaly A is seen to be a drained high abandoned entrenched meander, its dimensions suggesting that the main river was formerly much larger than it is now. A similar feature occurs to the west, across the river.

Gentle northwest dip is interpreted in the vicinity of Anomaly B, which is found to be an isolated outlier of young high-shale or high-clay-content sediments in which fine-textured dendritic drainage has developed. The asymmetry of the drainage within the anomaly area (i.e., stream *a* is much longer than stream *b*) is apparently caused by the northwest dip. Stream *a* is a resequent stream, and stream *b* is an obsequent stream. Radial streams which denote positive structural anomalies must all be either resequent or, less commonly, consequent streams.

Anomaly C is structurally caused, but the structure is negative instead of positive. Moderately gentle inward dip is indicated by the contrast between tributary streams *c* and streams *d*, for example. Most of the annular drainage appears to be developed along strike. Notable exceptions are streams and stream segments *e* and *g*. These small tributaries and tributary segments define two linear zones of non-resistance, probably faults.

When dip is extremely low, linear fingertip streams do not usually denote strike. The geometry of topographic relief and gently-inclined strata precludes this. Annular drainage patterns which reflect very gentle folds are generally formed by the larger streams. Small tributaries more frequently adjust to the traces of steeply inclined joint or fault planes.

The large area of "undissected grazing land" (Figure 1) is the unconsumed remnant of a gravel- and sand-capped regional pediment.

Anomaly D is simply an outlier of this surface, separated from the main body by the headward erosion of streams *h* and *i*. It is drained radially because it is an isolated positive topographic feature. It has no apparent structural significance. It is possible, however, that streams *h* and *i* are subsequent streams developed along northwest strike or along a fault or fracture zone parallel to fault *g*.

Linear streams such as *j* and *k* are consequent streams which flow down the gentle gravel and sand slopes of the capped pediment. They are linear because they developed on a smooth, uniform slope; they do not follow linear paths or zones of non-resistance. Their directions do not combine to define a curved fan-like surface. Streams *j* are parallel to the northwest, and streams *k* are parallel to the northeast.

Note the gently curved low break-in-slope along line *l*. This line separates the northwest-sloping surface (E) from the northeast-sloping surface (F). Surface E is slightly higher than surface F, as shown by the several contours sketched on the map from a published topographic map of the area.

Lower surface F cannot be satisfactorily explained by post-surface E downcutting and later planation, nor by headward erosion of northeast-flowing streams which could have destroyed the eastern part of original surface E. Instead, a fault displacement of an originally extensive surface EF, in which surface F was dropped down and tilted to its present slope, is postulated. Streams *m* and *n* appear to have etched out small linear courses along the fault trace.

More fault evidence seen. Note the floodplains of mature streams *p*, *r* and *s*, to the north. At points *t*, *v*, and *w* the floodplains become noticeably restricted, suggesting that at these points the streams encounter rocks of greater resistance than those lying upstream from these points. The interpreted fault may be extended to point y′, passing through points *t*, *v* and *w*.

In evaluating this area, it would be recommended that geophysical surveys be made at several places across this interpreted fault zone. If a fault is proven here, it apparently does not have appreciable displacement in the surface and near-surface strata, though some explanation must be advanced for the absence of the shaly strata of anomaly B from the eastern part of the mapped area. Perhaps the anomaly B strata were never deposited in the east; perhaps the Ta rocks (dotted pattern away from anomaly B) mapped in the east do not correlate with those west of the fault in the north center.

Buried strat trap indicated? In some areas fault displacement increases with depth. In other cases, geomorphically-detected surface faults coincide with deeply buried stratigraphic trap edges, suggesting submarine topographic trends (fault-produced) which influenced sedimentation during past periods of deposition.

Thorough analysis pays off. In the above illustration, which is a composite of numerous actual individual interpretations in numerous diverse areas, the following are apparent:

- Two-dimensional drainage anomalies need not be surface reflections of positive structural anomalies.
- Three-dimensional study and map compilation are required to evaluate two-dimensional anomalies.
- Three-dimensional study may disclose locally anomalous erosional histories, not reflected in stream directions or configurations, which may constitute valuable clues to structure and to relatively recent structural events. Data derived from such a study may assist in the understanding of the tectonic history of the area and may explain facts and relations brought to light by other studies (i.e., geophysics, subsurface). For example, the detection of a recently rejuvenated old tectonic trend, which may have influenced the deposition of stratigraphic trap sediments, may far exceed in value the location of a number of individual structural noses or domes.

Comprehensive photogeomorphic analysis is extremely time-consuming and demanding. It requires patience, attention to detail, long experience and advanced academic training. So, it may appear to be costly, especially when compared with rapid two-dimensional mosaic drainage studies.

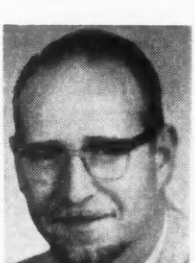
The important factor to consider, however, is not its relative cost alone, but its relative information-gathering value in an integrated exploration program. In today's competition, it is not a question of being the first to study an area, but rather one of being the first to analyze and understand an area adequately, since in most cases others already have studied it.

The photogeomorphologist's work must be part of a composite exploration program. It should precede geophysics. The work may suggest the most productive orientation and spacing of seismic, magnetometer or gravity survey lines; optimum airborne geophysical surveys, and/or specific centers and belts for more intensive geophysical investigation. Pre-geophysical photogeomorphology can in most, if not all, cases effect an increase in geophysical efficiency and productivity, thus decreasing costs. When used properly, pre-geophysical photogeomorphology frequently costs nothing, since it is more than paid for by savings in the geophysical program.

Photogeomorphology, like standard structural photogeology, is not, and never will be, the complete and final answer. It has, however, proven itself as an accepted and productive tool.

—The End

About the Author



Dr. Victor C. Miller, president, Miller & Associates, Inc., Denver, Colo., holds B.A. and Ph.D. degrees from Columbia University. After serving as photo-interpreter for the U.S. Army in Europe (1943-45), he joined Sinclair Wyoming Oil Co. as a photogeologist. During 1951 and 1952, he was associated with Geophoto Services, Denver, as photogeologist. From 1952 until 1955, he was a partner in the firm of Miller-McCullock, photogeologic consultants, of Calgary, Alta. He organized his present firm in 1955. He has made extensive geomorphic studies in Alaska, the Yukon and Northwest Territories, as well as in many areas of the United States.

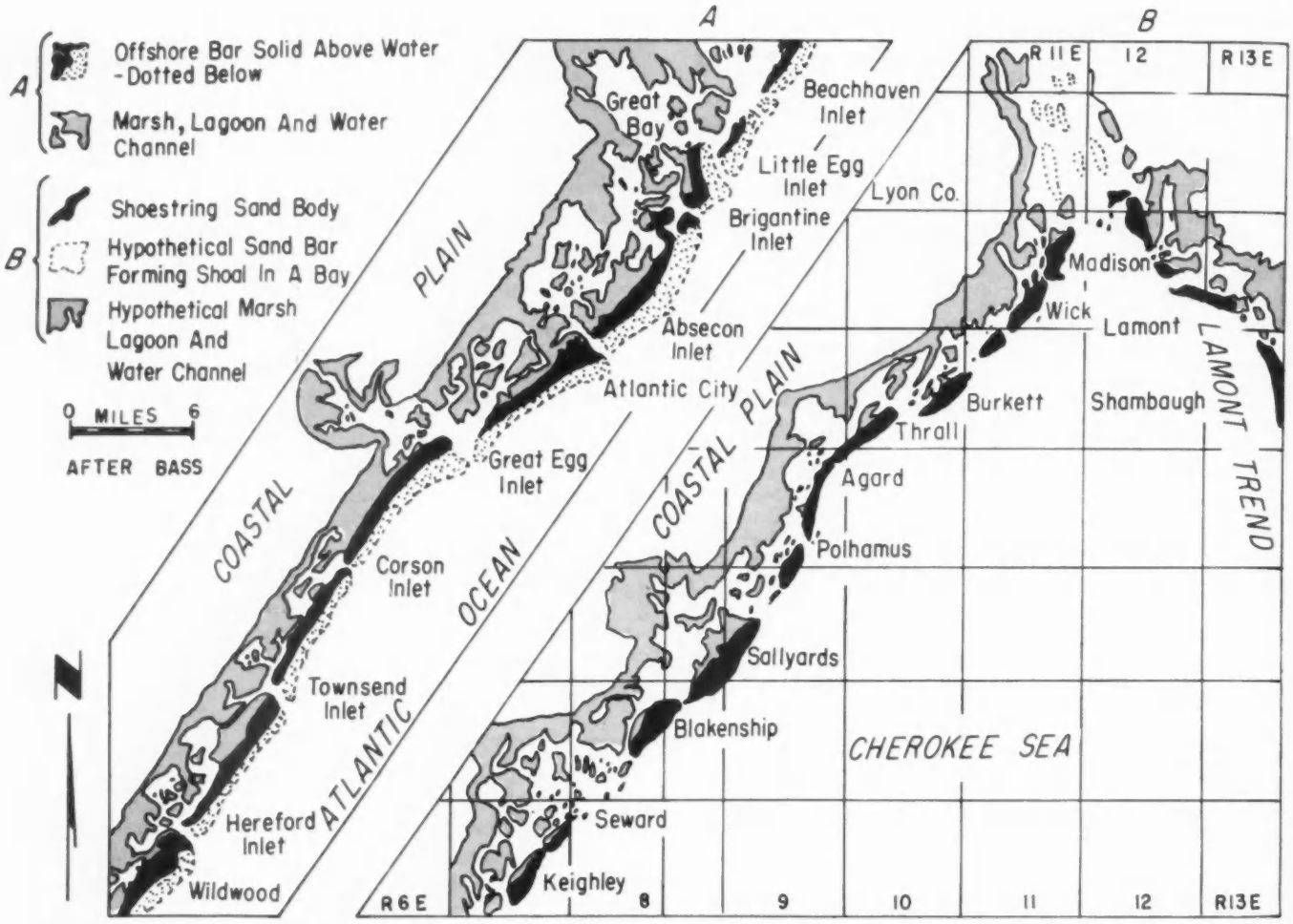


FIGURE 1—Bass[1,2] compared the shoestring sands of Kansas to the shoreline complex of the New Jersey coast. The latter is examined more closely in this article. External morphology of a sand body is a basic clue to its genesis, but this relationship is too often oversimplified. A closer, more recent examination of the New Jersey coast proved to be rewarding.

How to analyze strand lines from heavy minerals, facies data

By Edwin W. Biederman, Jr.,
Technical Group Leader and Research Geologist, Cities Service Research and Development Co., Tulsa

GEOLOGISTS LOOKING FOR OIL are largely concerned with sands. Where are the oil sands? How can their trends be predicted? Heavy mineral sands can be clues to the environmental sequence.

It is customary to call an elongate sand trend a barrier island or offshore bar, and a narrow, winding trend a channel. Implications are that a bar is marine and a channel is a fresh water environment. The external morphology may be a fundamental clue to the genesis of a sand body, but more often than not it is a gross oversimplification.

Bass[1,2] compared the shoestring sands of Kansas to the shoreline complex of the New Jersey coast (Figure 1). A closer and more recent examination of the latter proved rewarding. Although the Atlantic coast is not now an oil province, the laws of sedimentation are the same as they were for most of geologic time.

The barrier island complex at Barnegat Bay, New Jersey (Figure 2) is close to the standard concept of a barrier island. The subaerial portion of this sand body actually is only a small portion of the sand associated with this feature. Sand from the barrier island extends into the lagoon for a mile or more, forming a gradual, shallow slope. Deeper holes in this slope contain dark, fine-grained sediment; however, the majority of this material is located in the *landward* portion of the lagoon. This deeper area (the future zone of shales) is located nearer the mainland shore. A small beach may be present on the mainland shore; however, the marsh usually dominates.

Although the marsh may be almost a half-mile wide at Barnegat Bay, it is not nearly so important as at Stone

Harbor (Figure 3). A marsh attached to the mainland is subject to fresh water runoff. This distinction shows up in the color differences of the dried sediment. The marsh at Barnegat Bay is darker in color than that at Stone Harbor; the latter has much less fresh water runoff.

The geologist examining the cored interval must have some indicator as to where he is in the shoreline sequence. At Barnegat Bay, the concentration of heavy mineral sands occurs at a strategic location which can aid in the interpretation of ancient equivalents. The lagoonal shoreline of the barrier island shows relatively high concentrations of ilmenite and other heavy minerals.

Such a concentration has been observed in several locations, indicating that this is not confined to one area and a peculiar set of conditions. The grain size of the quartz grains associated with the heavy minerals commonly exhibits a very high degree of sorting. At Barnegat Bay, the prevailing wind is from the open ocean landward. Thus, the barrier island lagoonal beach lies in a protected zone, and very gentle wave action is usually the rule. This wave action is a very effective sorting agent.

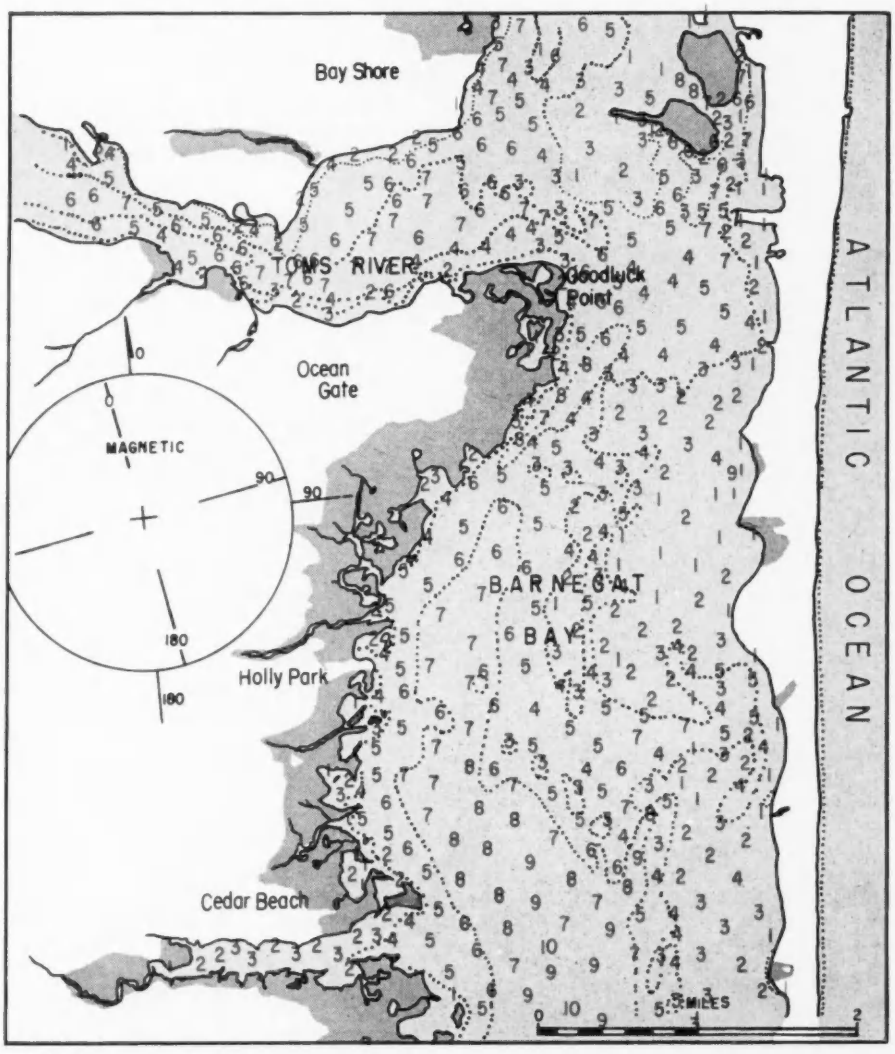


FIGURE 2—Barrier Island complex at Barnegat Bay, N. J., is close to standard concept of a barrier island. Note relative straightness of shoreline (extreme right). Sand from the barrier island extends into the lagoon for at least a mile. Concentration of heavy mineral sands occurs at strategic location which can aid the interpretation of ancient equivalents.

Depositional sequence. The important question is: What sequence would occur in ancient rocks, assuming that shoreline environments were preserved? For the purpose of this discussion, a transgressing sea is postulated, and a core through the shoreline sediments (Figure 4) might exhibit the following, proceeding from bottom to top:

- A carbonaceous shale. Coastal fresh water swamps and transitional marshes would be the first interpretation
- A thin sand body. One of the often-forgotten features is the small beach which may occur at the edge of the mainland marsh
- A dark gray marine shale. This represents the deeper-water lagoonal sediment
- A sandy shale or shaly sand with thin dark streaks. The barrier island sand extends quite a way into the lagoon
- A well-sorted sand high in heavy minerals
- A cross-bedded sand. In many cases dune sand would show only imperceptable differences
- A coarser sand with occasional carbonate cement. Although shells and shell fragments are a common part of the beach, their size and weight usually prohibit them from being carried into the dune region by the wind. Large storms which break through the dunes to form new channels alter this picture
- Sands containing more clay minerals and some carbonate. As Shepard[3] points out, continental shelves are extremely variable and seldom grade from sand to clay sediments as had been predicted in classical theory.

The second area considered is in the vicinity of Stone Harbor, N.J. As the map (Figure 3) indicates, the barrier island parallels the mainland coast, sheltering an area where lagoon and marsh sediments alternate.

The most obvious and generally the largest accumulation of sand is the barrier island. Its structure is quite variable, depending upon whether the bar is newly formed or is in a mature stage of development. For example, in the case of the newly-developed bar or extended spit, e. g., that above Hereford Inlet, the wind-blown sand forms a series of isolated dunes with extensive flat areas in between. The winter storms wash over this area and erode the sides of the dunes.

Sediment in this area is most likely to be a mixture of wind-blown and water-lain sand. In the summer months, the wind picks up light minerals and carries them to an isolated dune or on into the lagoonal flat, leaving very thin wavy bands of heavy minerals behind. As this area evolves, vegetation takes over, and a different pattern begins. In this special case, however, dune sand with its cross bedding would not be likely in a core. Carbonate, on the other hand, will be present.

FIGURE 3—Stone Harbor, N. J., marsh, attached to mainland, is much more extensive and is subject to fresh water runoff. This distinction shows up in color differences of the dried sediment. Main source of sediment is from seaward direction, since no large streams empty sediment into lagoonal areas.

Barrier Island sands have been studied and reported in literature at great length. This discussion will be focused on the sands that occur between the barrier island and the mainland. This area is most commonly termed the lagoon.

Examination of the coastal geodetic survey map in the Stone Harbor region (Figure 3) shows a complex series of marsh islands with channels and lagoons. There are no large streams emptying sediment into lagoonal areas; therefore, the main source of sediment is from the seaward direction.

Sand is brought along the coast by the long-shore currents and is sucked into the mouth of the inlet (in this case, Hereford Inlet) by the incoming tide. Once in the channel area, sand is carried by a strong current, four to eight knots, until it is deposited in the calm waters of the lagoons. The deposits so formed are called *tidal deltas.*

In terms of a potential reservoir, what would this look like? In essence, it will appear to be a sinuous stream channel that terminates in a *delta facing the wrong way, i. e., inland.* All channels showing on the Figure 3 do not have sand bottoms because only those that connect the sea with the inland lagoon will have the necessary current strength. Channels terminating in the marsh have mud bottoms and will not be considered in this discussion.

The distribution and length of channels are quite variable, ranging from five or six miles to one-half mile. Commonly, shell materials and coarser sand are dredged from these areas.

Tidal deltas have received relatively little attention as potential reservoir rocks. However, they contain large amounts of sand and attain a width of four miles or more. A detailed study of the large tidal delta at Barnegat Inlet was made by Lucke.[4] Krumbein[5] also discussed tidal delta sediments in connection with his study of Barataria Bay.

The problem to consider is that these deltas are constantly filling in the lagoon; and, in combination with subsidence, they can account for a large volume of sand. As stressed previously, there are no large streams contributing fresh water to this series of lagoons at Stone Harbor. The channels, lagoons and island marshes are almost as saline as the sea water coming into the inlet. When the incoming tide approaches its maximum depth, it spreads out over the top of the marsh, contributing a very fine sediment over a large area.

The question of source rocks has always curbed thinking concerning potential reservoirs. Sediment that contains the most organic matter should be of paramount importance. If it can be safely assumed that organic matter is the forerunner to petroleum, then the question as to which environment has the maximum amount is valid.

At Stone Harbor, 10 random samples were taken from the marsh and compared with 10 samples from the lagoon. The marsh samples contained about three times as much total organic matter as the adjacent lagoon. The mean value of 15.6 percent compares conservatively with the 18 percent average reported by K. O. Emery[6] for the California marshes. This difference was statistically signi-

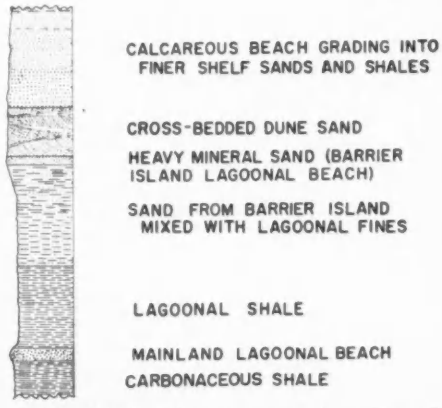

CALCAREOUS BEACH GRADING INTO FINER SHELF SANDS AND SHALES
CROSS-BEDDED DUNE SAND
HEAVY MINERAL SAND (BARRIER ISLAND LAGOONAL BEACH)
SAND FROM BARRIER ISLAND MIXED WITH LAGOONAL FINES
LAGOONAL SHALE
MAINLAND LAGOONAL BEACH
CARBONACEOUS SHALE

FIGURE 4—Columnar section through barrier island shoreline complex.

About the Author

Dr. Edwin W. Biederman, Jr., is a research geologist and technical group leader in geochemistry and sedimentology for Cities Service Research and Development Company, Tulsa. He was born in Stamford, Conn. He received his bachelor's degree in geology from Cornell University in 1952. After serving in the United States Air Force in Greenland, Dr. Biederman did graduate work at The Pennsylvania State University and received his Ph.D. in mineralogy in June 1958.

ficant at the 0.01 level. Hydrocarbons present in this sediment reflect this same difference. Figure 3 shows, furthermore, that the marsh area is large compared to other environments.

Applying this information to sand distribution, it becomes clear that the tidal deltas and tidal channels will be closest to the potential source rocks while the barrier island is the next closest sand. The migration problem is thus minimized in this simple approach.

At the present time, a great deal of research is being carried out on Recent shorelines by both oil companies and universities. It is anticipated that the present will continue to be an excellent guide to the processes that produced oil-bearing reservoirs.

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How to speed microfossil separation

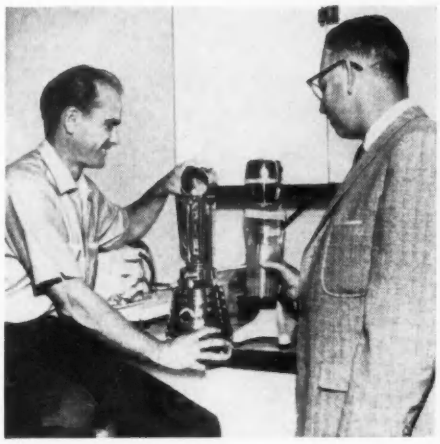


FIGURE 1

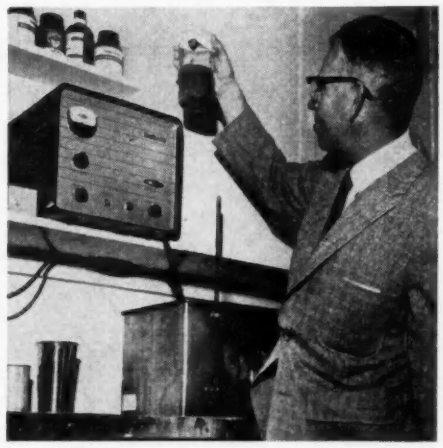


FIGURE 2

Electric blenders (left) similar to household kitchen mixer appliances are used to speed crushing of rock samples containing microfossils. Blender blades break up samples without damaging fossils. Figure 2 shows how clay and silt are cleaned from fossils through combined use of two laboratory devices. Machine with dial and control switches on upper shelf changes electric current into sound waves. Beakers containing crushed, soaked rock samples and a dispersing agent are placed in a water-filled steel box (on lower shelf). Sound waves passing through water and the mixture in the beaker separate fossils from clay and silt.

FIGURE 3

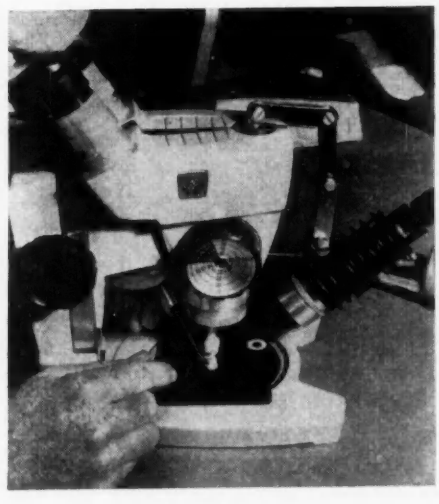


FIGURE 4

Above photo shows an air vacuum needle and trap devised to separate fossils from sand grains and simultaneously to place the fossils in a container until they may be emptied onto a slide. Paleontologist searches through sample with needle. The needle-tube device is, in effect, a miniature vacuum sweeper with a hole in the side of the tube casing. To pick up a fossil, operator puts finger over hole, closing the vacuum circuit and sucking fossil into casing. When sample has been fully searched, operator disassembles the casing and empties fossils onto a mounting slide. Figure 4 shows closeup of this rapid fossil-sorting technique in action. This method is faster and less tiring than conventional, strictly manual one-at-a-time fossil-picking technique, since operator can focus eyes on larger portion of the sample and does not have to maneuver each fossil individually.

ACKNOWLEDGMENTS

This article was adapted and published by permission of *Shell News*. These time- and labor-saving techniques were developed by E. H. Stinemeyer, division paleontologist, San Joaquin Division of the Pacific Coast Exploration and Production Area, Shell Oil Company, and his staff of 15 paleontologists, assistants and laboratory technicians. Stinemeyer appears in Figures 1, 2, and 3 at the right.

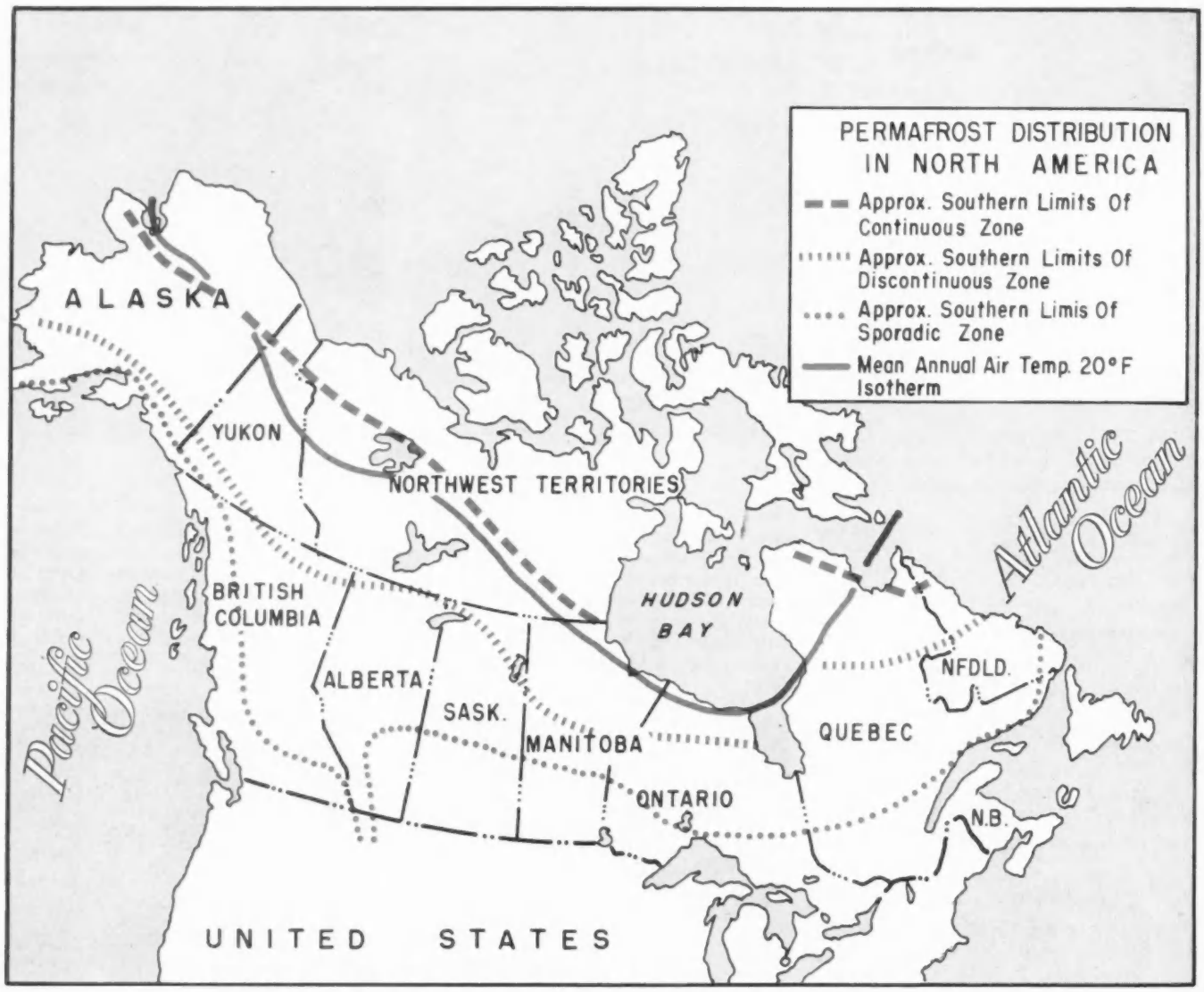


FIGURE 1—Permafrost distribution map of North America shows approximate southern limits of continuous, discontinuous, and sporadic zones. Continuous zone's southern limit closely parallels mean annual air temperature 20° F isotherm except in area east of Hudson Bay. Permafrost disappears northward beneath Arctic Ocean.

How to analyze reflection data

Permafrost varies regionally, may be locally absent or modified by big rivers, lakes

By Robert A. Boulware
Vice President, National Geophysical Company of Canada Ltd., Calgary, Alberta, Canada

ANALYSIS AND UNDERSTANDING of permafrost conditions are important not only to exploration in areas where such conditions exist, but also to production considerations in such regions. Although frozen ground and permafrost are subject to considerable variation in northern and adjoining Arctic areas, these conditions do not present insurmountable obstacles to reflection

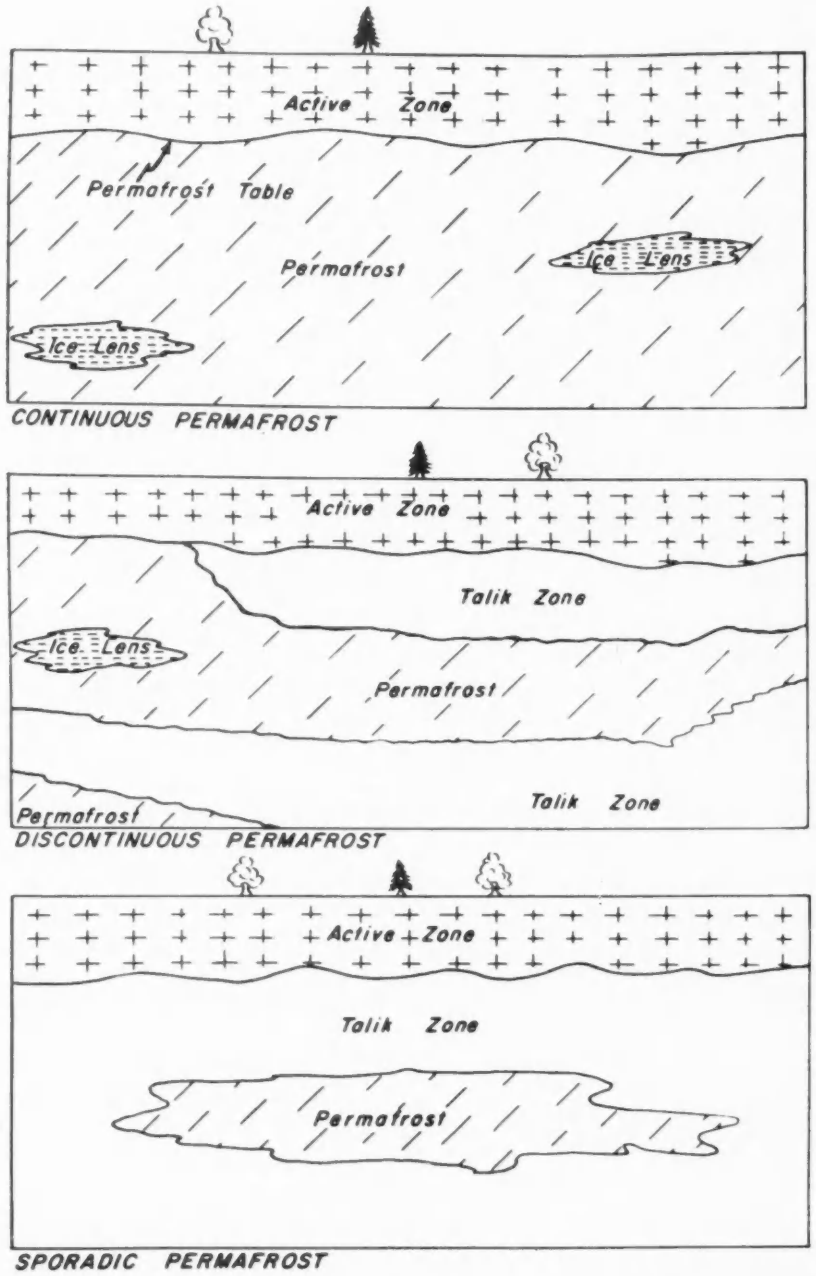


FIGURE 2—Diagramatic cross-sections show different types of permafrost. Southern limits shown in Figure 1 may generally be moving northward in North America, giving rise to isolated "residual" permafrost masses like one indicated in sporadic zone shown.

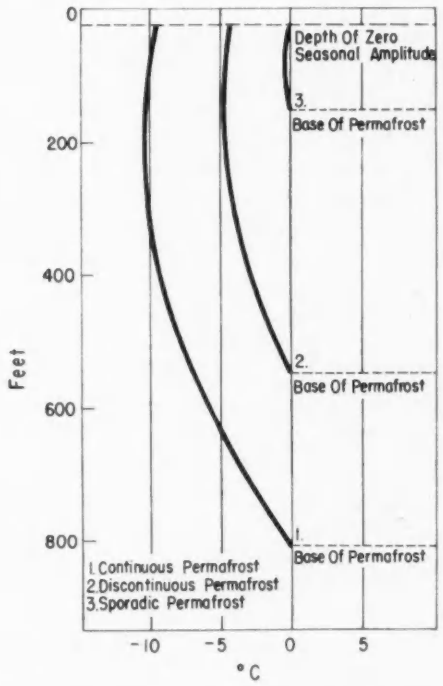


FIGURE 3—Generalized temperature gradients in degrees Centigrade for different types of permafrost are shown. Presence of a large lake or river cause strong variations in the presence or absence of permafrost and its type where present.

in permafrost areas

seismology because many similar problems, e.g. variable and secondary low velocity layers, velocity gradients, etc., have been dealt with successfully in recent years. Success of reflection seismograph techniques in overcoming permafrost problems has accelerated further knowledge of permafrost and related phenomena in particular as well as development of the oil industry in northern regions in general.

Permafrost has for many years presented a challenge to the construction engineer and more recently has become a problem to the geophysicist in interpreting seismic data in the search for oil-bearing subsurface features. The permafrost phenomenon was first reported in North America by McKenzie and other explorers, although the word permafrost was not coined until 1945 by Muller.[1]

Muller's work was stimulated by problems experienced in building the Alaska Highway and other associated defense projects in the North. Muller defines permafrost as perennially frozen ground occurring within the earth wherever the temperature remains below freezing for a period of several years. Permafrost distribution is closely related to the mean annual air temperature (Figure 1).

Types of permafrost. Most recent research has divided permafrost distribution on the basis of continuity into three categories: continuous, discontinuous, and sporadic (Figure 1, permafrost limits). The 20° F isotherm follows very closely the boundary of the southern limits of the continuous zone except for the area immediately east of Hudson's Bay. A marked difference in total snowfall east and west of Hudson's Bay is the principal contributing factor to this discrepancy.

Due to the sparcity of control points, the southern margin of each of these

zones is approximate and is subject to revision with additional field observations. Russian expeditions, making detailed observations by boring and by ground temperature measurement have made possible preparation of rather detailed permafrost isopach maps for most of the USSR. Eventually, such maps will probably be available for most of North America.

Typical cross-sections illustrating the characteristics of the three different classifications are shown by Figure 2. The active zone is defined as that layer near the surface which thaws and freezes with seasonal climatic changes. Thickness of this layer ranges from a few inches to 2 feet in the continuous zone and from 6 to 15 feet in the discontinuous and sporadic zones. The talik zone is a layer of unfrozen material found between the base of the active zone and the permafrost table—also within and below the permafrost zone (Figure 2). The thickness of talik zones varies considerably from point to point.

Permafrost thicknesses. The greatest total depth of the permafrost zone of 2,000 feet occurs in Siberia. In Alaska it is known to attain a depth of 1,300 feet at a point south of Barrow; in the Canadian Arctic Islands, it is thought to be about 1,500 feet thick. It thins rather abruptly towards the north, disappearing completely beneath the Arctic Ocean, and gradually thins southward into discontinuous and sporadic bodies. The distribution within the discontinuous zone varies from principally frozen areas with isolated "islands" of thawed material to predominately thawed areas with isolated "islands" of frozen material.

Permafrost is primarily a relic of the Pleistocene ice age, but under certain conditions it may be forming today in some localized areas. Such is the case in some portions of northern Siberia, according to reports from the USSR. During the last century in North America, the southern limits of the perennially frozen ground have receded northward.

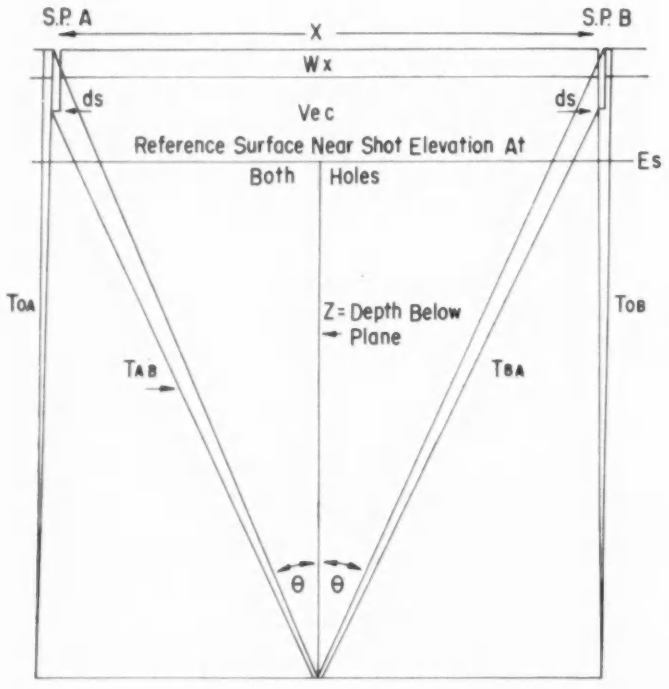
Arctic subsoil variations. Unfrozen zones, both near the surface as well as at depth; zones of dry permafrost; and pure ice lenses are commonly found within the permafrost zone. Dry permafrost is defined as material with temperatures below the freezing point but devoid of moisture.

Factors which contribute to these variations in the characteristics of the permafrost zone are many: distribution and texture of material; solar, earth and atmospheric radiation; water content, and numerous others.

Regarding snowfall, it is interesting to note that the total precipitation in many of the Arctic areas is less than six inches per year less than some desert regions.

Temperature gradients within the permafrost layer vary vertically as well as horizontally and from year to year. Representative temperature profiles within the three zone classifications are illustrated by Figure 3. Muller (1945) and Black and Barkesdale[2] report that lakes and a few large rivers located in the continuous zones lie in thawed areas somewhat larger than the basins they occupy. The fact that large zones underneath some lakes are unfrozen first became known during the course of seismic operations conducted on the U.S. Naval Petroleum Reserve 4 in northern Alaska.[3] It was felt that seismic indications of structural lows underneath many of the lakes might be due to an unfrozen condition underneath the lakes. To confirm this theory, a velocity test hole was drilled in 1950 to a depth of 1,233 feet below one such lake.

Since physical characteristics of permafrost vary widely, seismic velocities within this zone will also be subject to rather wide variations. Velocities will depend upon whether or not the zone is entirely below freezing, whether it contains pure ice lenses or is partially dry, along with other contributing factors such as the nature of the material prior to freezing.



Example Of Plane Correction At S.P. A
Near Trace
$tc = 2(tecA) + tuh\,A$
Far Trace
$tc' = tecA + tecB + tuh\,B$

Where: Em = Shot Point Elev.
Es = Plane Elevation
Vec = Corr. Velocity
Ds = Shot Depth
Dec = (Em-Ds) − Es
tec = Dec / Vec

Depth Computation
T_{AB} − Corr. To Plane = T_{XA}
T_{BA} − Corr. To Plane = T_{XB}
T_{OA} − Corr. To Plane = T_A
T_{OB} − Corr. To Plane = T_B

$\frac{T_{XA} + T_{XB}}{2} = Tx$

$\frac{T_A + T_B}{2} = Tv$

$\frac{Tv}{Tx} = \cos\theta$

$Z = \frac{X}{2\tan\theta}$

FIGURE 4—Where velocities are uncertain, the depth of the permafrost interface may be determined by the method outlined here. No velocity data are required through the questionable zone.

Incompetent sediments with a high ice content will have a higher velocity than the same materials unfrozen or when they are frozen but dry. Depending upon the physical properties of the material and the moisture content, the increase in the velocity by freezing can range from 1,000 to 8,000 feet per second.

In seismic computations, the presence or absence of permafrost, the thickness when present, and uncertainty of velocity causes problems in determining the depth to reflecting interfaces. Therefore, a means of measuring the depth of the permafrost zone as well as the seismic travel time through the zone of frozen material is desired.

The refraction technique normally cannot be applied to measure the depth of the frozen zone because the velocity of the underlying material is usually lower than that of the permafrost. However, some success by refraction has been reported where the permafrost is situated upon bed rock having a higher velocity than that of the permafrost. Such a case is an exceptional one which will not be encountered very often.

In some cases, it is possible to obtain reflected energy from the base of the permafrost. Where this is possible, the depth can be determined if accurate velocity information within the permafrost is available. Where the velocity is uncertain, the depth of the interface can be determined by the method outlined by Figure 4. The principal advantage of this method is the fact that no velocity information is required through the questionable zone.

Having determined this depth and the corresponding travel time, the deeper reflected events from within the sedimentary section can be corrected for any variations caused by the permafrost zone. If reflections are not obtainable from the base of the permafrost, the depth to a deeper reflecting horizon within the sedimentary section can be measured in the same manner, provided its depth is not too great in comparison to the length of the geophone spread. The accuracy of the method diminishes as the depth of the reflector increases.

Fortunately, the lateral changes in permafrost conditions in most areas are consistent enough to preclude the necessity of resorting to the procedure outlined above, except in the immediate vicinity of lakes and large streams. This is particularly true in the continuous zone. The magnitude of subsurface structural relief in many permafrost areas will be sufficiently great to make an inaccuracies caused by permafrost variations tend to be negligible.

The computation procedure can be helpful in low structural relief areas

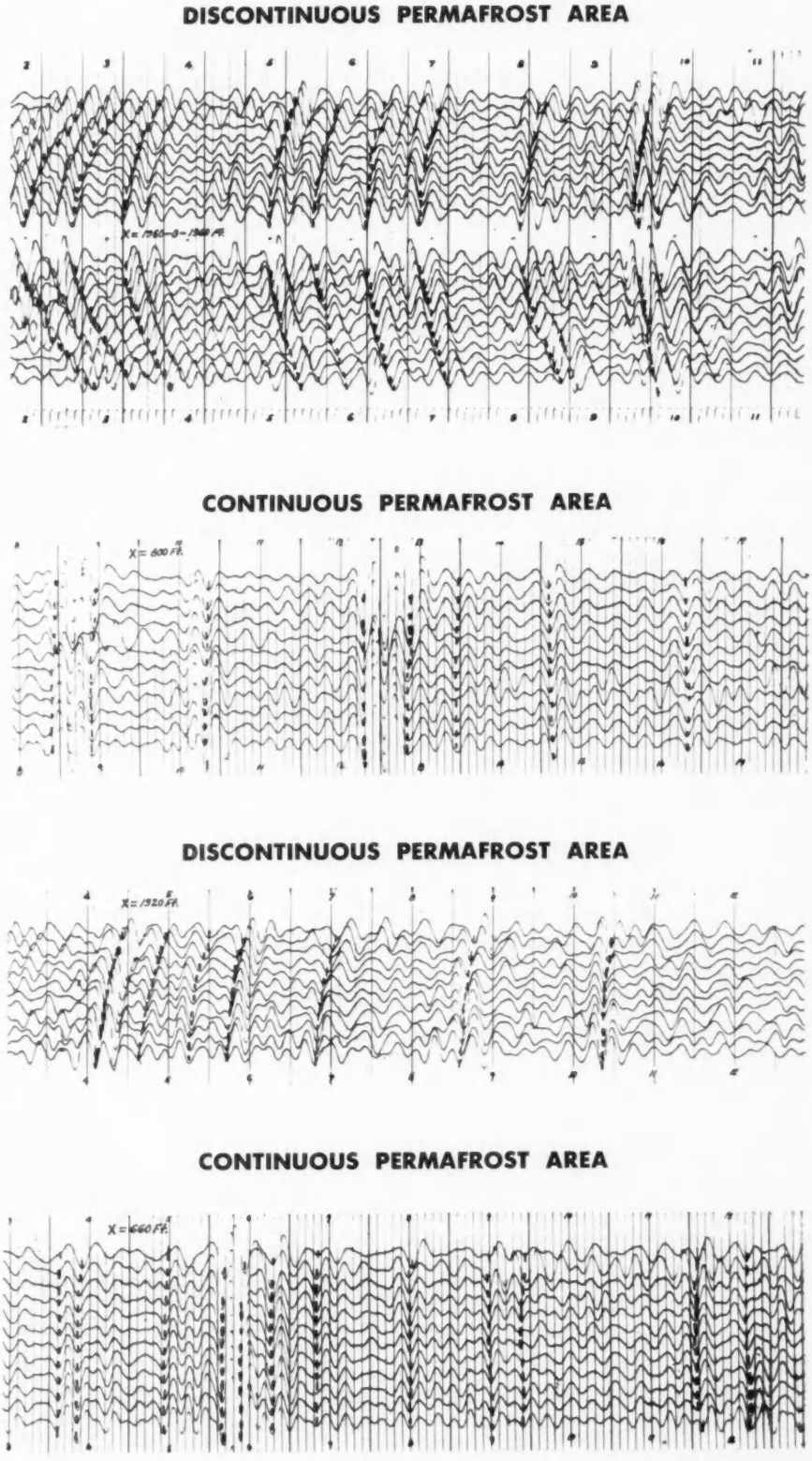


FIGURE 5—Records from seismic work in continuous permafrost areas show superior quality to more irregular ones from discontinuous permafrost regions. Some deterioration in reflection quality takes place when surface is thawed.

where difficulties are encountered. It has been used with success in many areas where near surface low velocity zones of variable thickness are buried between zones of higher velocity. Regardless of whether or not an area of slight or great subsurface structural relief is being dealt with, the seismologist must continuously check the accuracy of seismic results by use of isopachs, comparing structural features to surface features, and to known information when available.

Recording techniques in permafrost areas do not differ materially from those commonly employed in other areas. Large charges in shallow holes in some areas will tend to generate "ground roll" energy within the active and/or talik zones. "Ground roll" energy interferes with reflected energy. In some areas, good recordings are obtained from holes only 10 to 15 feet deep. Excessively large charges will sometimes produce high amplitude background noise. All of these recording problems and suitable remedies thereto are familiar to the geophysicist, since in all but the most extreme cases these problems and their adverse effects are encountered in some form in practically all areas.

Some difficulty has been experienced in deterioration of reflection quality when the surface is in a thawed condition. This effect is due to the difference in the earth to geophone coupling and is generally rather slight. It is frequently noticed in the muskeg areas of western Canada. Geophones with extended spike bases (sometimes as long as two feet) have been used to advantage in some areas while the surface is unfrozen. Sample recordings from permafrost areas are illustrated by Figure 5.

Permafrost partly beneficial. While causing many problems for the construction engineer and the seismologist, the permafrost layer has been of great benefit to the geologist, paleontologist, and archeologist by preserving almost perfectly a fabulous amount of material for study and observation. Many different plants (including whole forests of tree stumps), nearly a hundred species of diatoms, numerous rodents, mollusks, sponges, and thousands of bone specimens from at least 20 different large mammals have been found and identified in Alaska alone.

Whereas much has been said regarding hazards and hardships of oil operations in permafrost regions, such difficulties pertaining to reflection seismic work have largely been overcome, since permafrost problems in this realm have their counterparts elsewhere together with appropriate remedial techniques.

About the Author

Robert A. Boulware is vice president of National Geophysical Company of Canada Limited. He has been with National during the past 18 years, 11 of which have been spent in western Canada. He has served in various capacities including seismograph party and chief computer. Boulware is a member of the Society of Exploration Geophysicists, The Canadian Society of Exploration Geophysicists, Alberta Society of Petroleum Geologists and the European Society of Exploration Geophysicists.

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Check available geophysical coverage

CONSIDERABLE RECONNAISSANCE geophysical coverage, in particular aeromagnetic maps, are available through the United States Geological Survey. This work has been done not in such detailed fashion nor in such highly prospective areas as to compete with private industry, but to assist in scientific investigation in areas which are not too well known geologically. Examples of such areas are close to the Appalachian structural front in Pennsylvania, certain Rocky Mountain area intermontane basins and remote regions in Alaska. U.S.G.S. aerial magnetic coverage was found useful for comparison with a mobile ground magnetic survey (WORLD OIL, March 1960, pp. 82-84).

Do earth currents cause pipe line leaks?

SOME SEDIMENTARY STRUCTURES show high self-potentials in surface electrical surveys (WORLD OIL, April 1960, pp. 97-98). There may be a measurable potential drop across the surface trace of a fault. Much has been written in pipe line technology about "hot spots" (localities of chronically recurring leaks) where electrical flow has caused lines to be pitted into eventual pinhole leaks.

Some currents causing such leaks may be the earth's natural electrical interchange which, in turn may be diagnostic of geological structure. Technical liaison between exploration and pipe line departments of large oil companies is virtually unheard of. Here's one aspect in which such liaison might pay dividends.

Earth's heat flow an oil search tool?

CURRENT RESEARCH indicates that thermal gradients of different sediments vary significantly. Hence it is hoped that knowledge of such phenomena may be utilized to find oil and gas.

Reliable depth-temperature data tabulations for the U.S. and Canada have recently been updated and are expected to be published in the May 1961 issue of WORLD OIL.

This photograph shows truck-mounted vibratory seismic equipment, with truck at right jacked up indicative of actual field operation with rear wheels off the ground (arrow). Inspecting the equipment are W. O. Heap (left), senior research engineer, and G. H. Westby, president, Seismograph Service Corporation, Tulsa, Okla.

Vibratory seismic method is important breakthrough

THE VIBRATORY seismic method of exploration developed by Continental Oil Company is certain to enjoy more widespread use in the future. This technique permits full control of the signal loaded into the earth and permits use of several energy sources (slave hydraulic vibrators) simultaneously. The resultant received signal can be correlated against the signal introduced into the earth, thereby reducing or eliminating extraneous noise. Explosives and shot holes are not required, permitting exploration in populous or desert areas, or where drilling and/or explosives costs are prohibitive.

The system provides introduction of the desired signal into the earth by employing a master control signal recorded from magnetic tape and transmitted via radio to slave hydraulic vibrator units operating in synchronism. This feature allows introduction into the earth of the frequency spectrum most applicable to conditions of the earth's natural filtering effects in any given area or location. As many vibrators, operating simultaneously, as are necessary to produce the desired energy, may be used.

Effective control of the input signal and use of several simultaneous input vibrators permits rapid coverage by vibratory seismic parties.

Ability to correlate the recorded signal with the signal actually introduced into the earth provides noise-free seismic records and a clear picture of the desired reflected energy. Magnetic tape recordings obtained in one crew-day of work can be correlated with the master input signal in less than one man day. This provides rapid processing of field data at a speed equivalent to previously-employed computation procedures.

Classify limestones 'by the numbers'

AN EARNEST EFFORT to simplify classification of limestones has been published in the *Journal of Sedimentary Petrology* (The American Upper Ordovician Standard, Classification of Limestones of the type Cincinnatian, June 1960, pp. 283-296). This work recognizes seven limestone types and may have rather general application to carbonate rocks.

Simplified yet diagnostic carbonate classifications should provide rapid correlations exemplified by the late Earl McCracken's work (Insoluble residues provide good regional correlations, WORLD OIL, August 1, 1959, pp. 79-82 and 110). Classifications that permit a digital approach are also in accord with the current trend toward analysis of geologic findings through electronic data processing (WORLD OIL, April 1960, pp. 105-111). Whether geologists like to work with numbers or not, any feasible way developed to reduce geological data to digital form will accelerate its use and coordination and will increase the productivity of geologists.

Offshore seismic 'singing' suspected? Just listen!

LIMITED RESEARCH by a major company in the U.S. Gulf of Mexico indicates that offshore areas where seismic work may be hampered by multiple reflections off the sea bottom may be determined *in advance* without shooting. Some form of continuous energy, perhaps wave or tidal action, may be picked up in geophones in areas where bottom conditions cause water reverberations to occur on the seismic records when shooting is done. That is, "singing" may be observed, whether the shots are made or not.

The multiples problem was fully described in WORLD OIL, May 1960, pp. 156-160. Further research may determine whether or not the shotless singing phenomenon applies to all areas which will provide multiple problems when they are shot.

Refraction a strat trap search tool?

THE POSSIBILITY of using refraction seismograph to determine the lateral extent of subsurface formations and to determine formation thickening, thinning and pinchouts is being investigated by at least one geophysical survey company. This is one of many manifestations of the renewal of interest in refraction seismic work (WORLD OIL, April 1960, pp. 114-116).

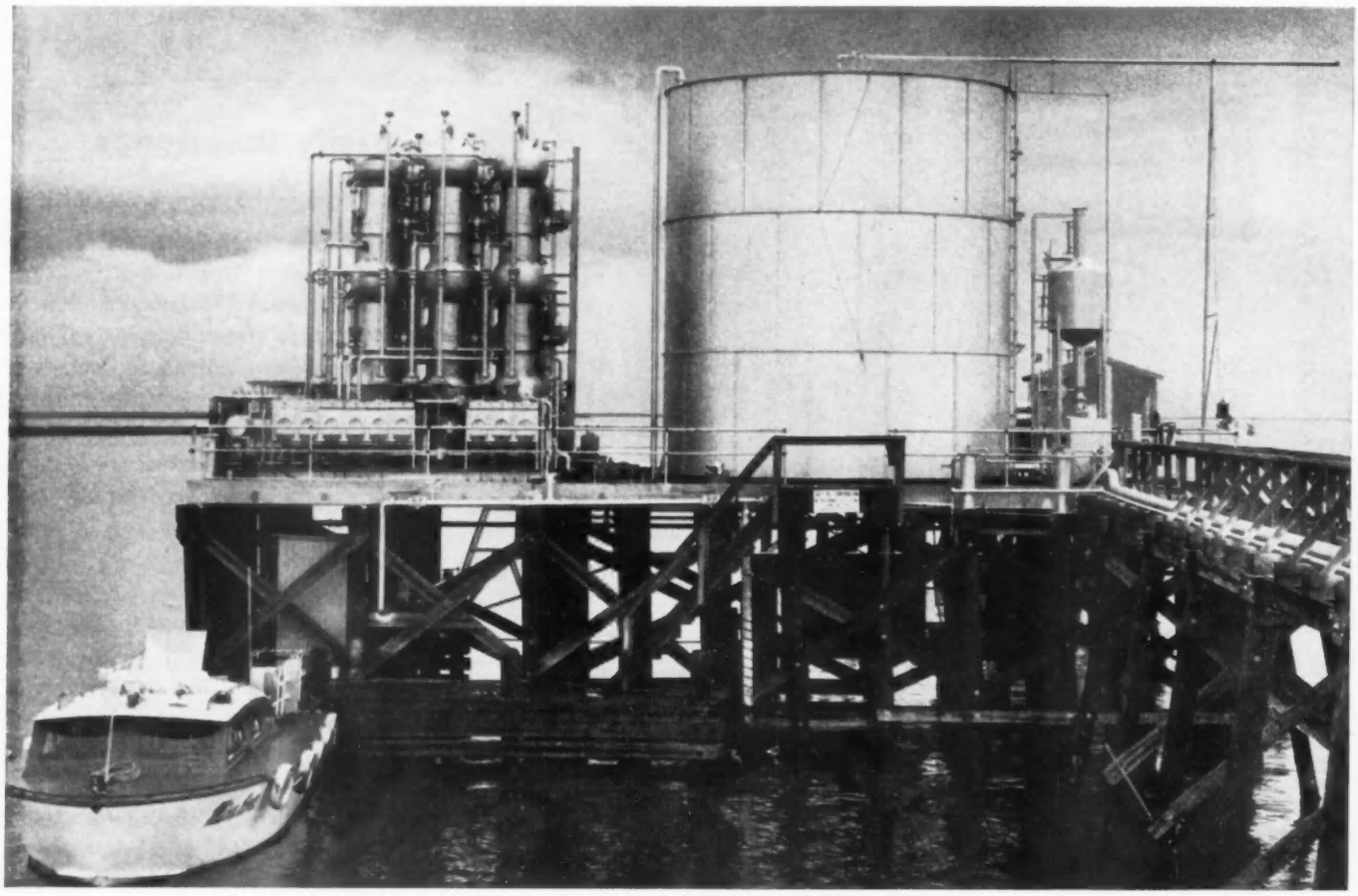


FIGURE 1—Gulf Oil Corporation's first automatic tank battery in South Louisiana features stacked separators, automatic well testing facilities and lease automatic custody transfer. The 15 vessel skid-mounted separator unit is shown at left of 1,500-barrel surge tank. Automatic custody transfer unit is at right of tank. House in rear contains control equipment and generators.

In South Louisiana . . .

New production facility automated from wellhead to pipe line

By Raymond H. Peacock
Petroleum Engineer
Gulf Oil Corp., New Orleans

THE FIRST COMPLETELY automatic tank battery to be installed by Gulf Oil Corporation in the South Louisiana Area has been completed and in operation since June 1959. The battery serves an operating area comprised of 14 units located in Plaquemines Parish, Louisiana. Royalty interests in the units vary making it necessary to meter and sample the production from each prior to commingling in the surge tank. At present there are 13 producing units with a total of 24 wells producing a combined daily allowable of 1,783 barrels.

Major producing equipment on the battery consists of a stacked separator production unit where all gas and oil is metered prior to commingling, one 1,500-barrel surge tank, two 8 foot x 27½-foot emulsion treaters and a skid-mounted automatic custody transfer unit (Figure 1). Complete automatic well testing was also incorporated in the installation.

The installation offers several advantages over the conventional type battery:

1. Automatic well test system relieves operating personnel of certain amount of well test work, allowing more time to be devoted to other duties.

2. Utilization of automatic well-test systems will result in a larger and

more reliable amount of well test information.

3. A more reliable and independent operating installation. This is most important on marine locations where work schedules of operating personnel are likely to be affected by adverse weather conditions.

4. More effective storage with fewer tanks resulting in a smaller installation investment.

5. More accurate measurement of crude with the positive displacement meter than that obtainable with manual hand gaging.

6. Less crude oil weathering loss due to the reduced amount of weathering time.

7. Continuous accurate monitoring of BS&W content of crude during entire pipe line run.

8. Delivery of crude to pipe line is spread out over a 24-hour period, resulting in less tendency to overload the oil gathering system during daylight hours.

9. A smaller and more compact installation, resulting in decreased maintenance costs.

Only minor problems have been encountered since the battery was installed. These problems have been resolved and the installation is now considered operational.

Total cost of the tank battery was approximately $203,000. Three types of installations were considered initially:

- Separate producing and treating facilities for each individual unit with production commingled into common storage.
- Conventional type battery with production commingled downstream of the metering separators into common treating and storage facilities.
- Automatic tank battery with production commingled downstream of the metering separators into one surge tank employing automatic custody transfer.

The first installation was not considered in the final evaluation due to economic and operational reasons. The automatic tank battery installation was incorporated, resulting in a net savings of approximately $65,000 as compared to the first installation, and $20,000 as compared to the second installation. Cost savings realized as compared to the second type was affected by the utilization of automatic transfer, which eliminated a certain amount of storage. Platform space to accommodate the facilities was also reduced by this type installation.

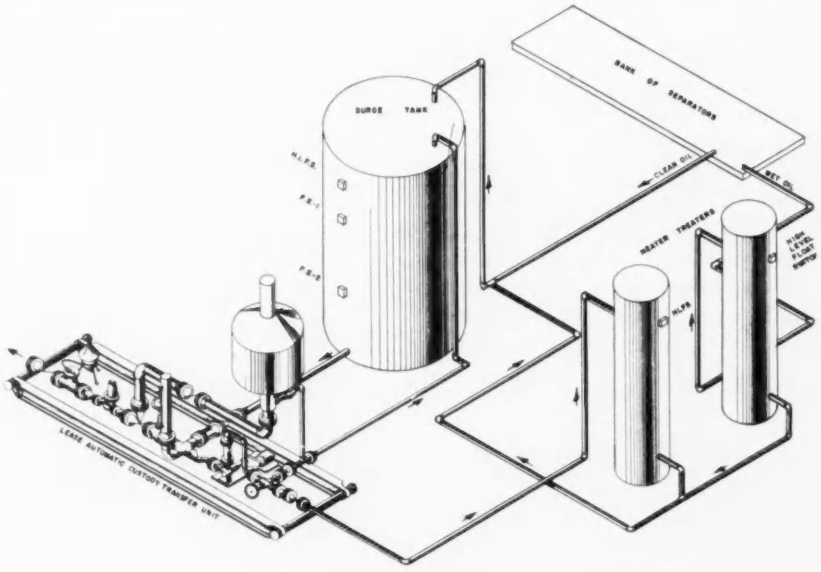


FIGURE 2—Here is a schematic flow diagram of the automatic battery.

The high cost of construction of oil-production and handling facilities is common to the water operations of the Mississippi Delta. This factor was significant in the design of this installation, since it was necessary for production from each unit to be handled as though it were from a separate lease.

A preliminary engineering study indicated that the installation of separate producing and storage facilities for each individual unit would not be economically feasible. In lieu of this, installation of unit oil and gas separation facilities with commingling of production downstream of the metering separators into common storage was selected as the most acceptable design. To further reduce installation cost, the unit separators, along with their associated metering equipment, were stacked and skid-mounted to form a compact production unit occupying only 300 square feet of platform space.

Further study indicated that the employment of continuous throughput design utilizing LACT would reduce the necessary tankage requirements approximately 50 percent over that required for conventional type storage. The platform space would be reduced by the same amount.

This type installation required a certain amount of safety equipment designed to initiate emergency action upon equipment failure. These safety controls were incorporated into the installation along with automatic well test equipment.

MAJOR PRODUCING EQUIPMENT

The tank battery is composed of the following equipment:

- One 28 foot x 60-foot concrete slab production platform. This platform contains the skid-mounted production unit, surge tank and ACT unit.
- One 16 foot x 32-foot concrete slab platform containing oil-treating facilities.
- One 20 foot x 24-foot timber-type platform containing the pipe line pump and associated automatic controls.
- One 12 foot x 14-foot timber-type platform containing electrical generating and automatic well test equipment.
- One 15½ foot x 19½-foot skid-mounted stacked separator production unit consisting of 14 spherical 3-phase metering production separators, one spherical 3-phase metering test separator, and one 36 inch x 10-foot vertical meter prover tank. The skid-mounted unit is completely equipped with individual unit gas meter runs, oil discharge headers, water discharge header, in-line fluid samplers for each unit, inlet production-test manifold with three-way solenoid controlled diaphragm operated valves and integrating gas orifice meter on the test unit separator.
- One 1,500 barrel capacity surge

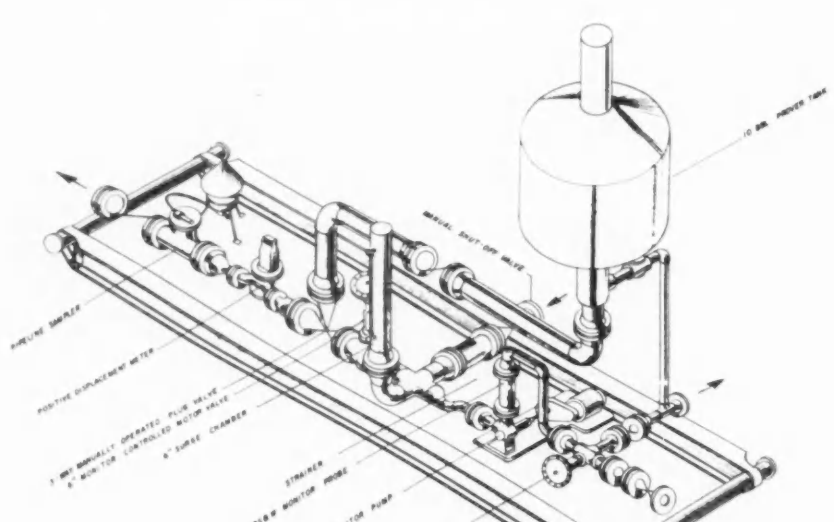


FIGURE 3—This skid mounted automatic custody transfer unit is actuated by the two lower float switches on the surge tank. Automatic controlled 4½-inch by 10-inch horizontal duplex piston pump delivers oil to pipe line.

tank equipped with three float control switches.

- One 5 foot x 17-foot skid-mounted ACT unit.
- Two 8 foot x 27½-foot emulsion treaters.
- Two 10,000 watt engine driven generator sets with automatic control panel.
- One electrically operated well test control panel with data print-out recorder.

EQUIPMENT OPERATIONS

Gathering facilities. Production from each individual unit is routed to the platform through each well's respective flowlines, and from the inlet manifold into a three-phase separator. Gas is metered with a bellows-type orifice meter and combined into a common sales gas line.

All free water is discharged into the sump tank for disposal. The unit oil production is metered, sampled for BS&W content and routed to either the 8 foot x 27½-foot treater or the 1,500-barrel surge tank.

The in-line fluid sampler is utilized to sample oil production. It is designed to recover a representative sample during the entire dump period of each separator dump cycle. The sample is stored in a container for daily analysis of BS&W content. The operation and accuracy of the samplers to date have proven satisfactory.

Each unit separator is equipped with a hi-level float switch to shut-in the respective unit wells in the event of mechanical failure of separator controls causing high liquid level in the separator.

The 10-barrel meter prover tank is used for monthly determination of the meter factor for each of the metering separators.

Treating facilities. Treating facilities consist of two 8 foot x 27½-foot emulsion treaters (Figure 2). The produced oil-water emulsion presents no difficult treating problem. One treater is used for all wet-oil production from the production unit. Clean oil from this treater is routed to the 1,500-barrel surge tank.

The second treater is used to treat only the unmerchantable oil received by the ACT unit. This arrangement was selected in lieu of one treater performing all treating requirements to exclude overloading and possibly contaminating the entire volume of surge tank oil. This latter situation would probably result in complete lease shut down due to total lease production exceeding the treating capacity of a single treater.

Each treater is equipped with a float control switch to initiate lease shut down operations when high fluid level occurs.

Surge tank. The surge tank is a standard 1,500-barrel bolted stock tank equipped with three float control switches. Clean oil is received by the surge tank directly from the production separators and from the treater.

The upper float switch serves only to initiate emergency measures upon starting failure of the pipe line pump. The switch is wired in series with the float control switches on the emulsion treaters so that a high fluid level in either will route all incoming production into a common line. This line is equipped with a solenoid controlled, diaphragm operated motor valve that also closes upon actuation of any of the subject float switches so that all wells are producing against a closed valve. Build-up in flow line pressure will actuate a high-low safety valve installed at each well head, resulting in complete field shut down. The upper float switch in the surge tank is located four feet from the top of the tank, thereby providing approximately 250 barrels of storage from initiation of emergency action until final field shut down.

The lower and middle float control switches are mounted 7 feet and 16 feet, respectively, above the bottom of the tank and control the working level in the surge tank for each pipe line run. The lower float switch was so positioned above the tank discharge outlet to assure a minimum head of 7 feet on the positive displacement meter at all times.

In normal operation, actuation of the upper working level float switch will energize the pipe line pump automatic start-stop control. If the oil is merchantable, as determined by the BS&W monitor, the pipe line pump will start and continue pumping until the oil level in the surge tank is pumped down and the lower float switch is actuated to stop the pump.

ACT unit. The chief function of the automatic custody transfer unit is to effect transfer of ownership of produced oil from the producer to the purchaser. The unit also is responsible for measurement and recording of all data pertinent to this type of oil ownership transfer.

A general discussion of flow through the unit (Figure 3) is as follows:

1. Oil enters the unit from the surge tank discharge through a six-inch manual shut-off valve. This valve is closed only when proving the positive displacement meter. The valve is equipped with a bleed so that any leakage through the valve (while in the closed position) can be detected.

2. Oil then is routed through a six-inch strainer equipped with No. 24

mesh bronze screen. The strainer serves to retain any solid particles that might be entrained in the fluid and cause possible damage to the PD meter.

3. Immediately downstream from the strainer, oil is pumped over a capacitance type BS&W monitor (Figure 4). The monitor pump is a 1¼-inch rotary type, driven by a one hp electric motor. Pumping rate over the capacitance probe is approximately 30 bph or 15 percent of the total throughput volume.

The monitor pump starts and monitoring begins actuation of the upper working level float control switch in the surge tank. After being monitored, the oil is directed by a 3-way valve either to the surge tank or to the emulsion treater. This diverter valve is monitor controlled and upon a signal from the monitor indicating nonmerchantable oil, it automatically diverts flow from the surge tank into the treater. When the oil regains the merchantable status following treating, the diverter valve re-routes flow back into the surge tank.

4. A six-inch surge chamber equipped with a float control switch is installed in the throughput line downstream of the strainer. A low fluid level in the surge chamber will actuate the switch, preventing the pipe line pump from starting. This assures a flooded suction on the P D meter and pipe line pump at all times.

5. Leaving the surge chamber, the oil flows through a six-inch monitor controlled, diaphragm operated control valve. This valve remains closed except during the pipe line run. During the pipe line run cycle, the valve is controlled by the BS&W monitor. In the event unmerchantable oil is detected, the valve closes and remains closed until the oil again assumes merchantable status. This design is incorporated to eliminate any possibility of pumping bad oil to pipe line.

6. Flow from the six-inch motor valve enters the 2½-inch positive displacement meter. In addition to the automatic temperature compensator, ticket printer and other accessories, the water is equipped with a set-stop counter. This enables the operator to dial into the meter the desired cumulative number of barrels of oil to be run through the unit during the month. When this amount has been metered, the set-stop mechanism will shut-off transfer, resulting in field shut down.

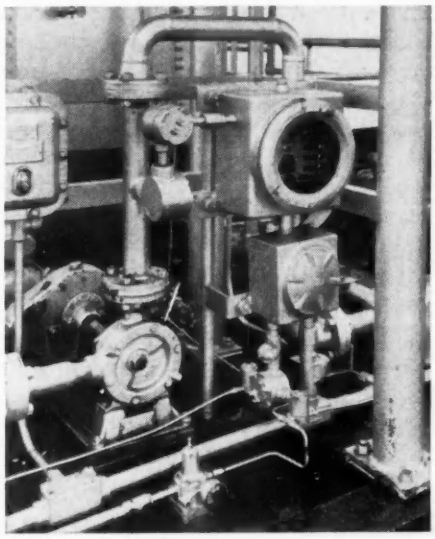


FIGURE 4—A capacitance type BS&W monitor is used on the ACT unit. The 1¼-inch rotary pump which delivers oil over the capacitance probe is driven by a one-horsepower electric motor.

An electrical interlock mechanism will stop the pipe line pump in case of meter malfunction or insufficient flow rate.

7. A proportional type sampler is installed in the line immediately downstream from the positive displacement meter. The sample is stored in a vapor-proof container until withdrawn for gravity determination and other tests to determine the presence of any impurities. The sampler is actuated by a vane-type impellor mounted on the sampler and located in the path of flow. The quantity of sample recovered varies directly with the flow rate through the sampler.

8. The meter prover is a 10-barrel atmospheric type tank, built in accordance with API Code 1101, and precisely calibrated. The prover tank is used to establish a meter factor for the PD meter. This tank is elevated so that a minimum head of seven feet is maintained on the meter during proving operations.

The prover tank is filled by energizing a pushbutton switch to open a diaphragm control fill valve in the calibration tank fill line. This switch also starts the circulating pump to perform the fill cycle. This switch is located on top of the prover tank so that the operator may de-energize the switch to close the fill valve when the fluid level has reached the proper level. After the calibration tank is filled, the tank discharge valve is closed and the 3-way manually operated valve is positioned to route the flow from the prover tank into the PD meter.

The pipe line pump then is started by energizing the manual pump start-stop switch. After 10 barrels of oil have been pumped from the prover tank through the PD meter, a low level float switch in the prover tank is actuated to stop the pipe line pump.

Pipe line pump. Installation pumping requirements are fulfilled by a 4½ inch x 10-inch horizontal duplex piston pump powered by a natural gas engine. The engine is equipped with an automatic engine controller to start-stop the engine at predetermined pressure, temperature, time, tank level or relay contacts, and has over-crank and warm up provisions and tattletales.

In normal operation, the actuation of the upper working level float switch in the surge tank will start the pump engine. The engine starter is a solenoid operated air-gas design. Holding relays in the controller panel provide a warm-up period for the engine prior to engine speed-up and clutch engagement.

During the pipe line run, a time-delay relay incorporated in the controller is kept energized by a pulse transmitted by the PD meter. Should this pulse not be received due to meter malfunction or insufficient flow rate through the meter, the relay will time out, resulting in pump shut down. If the oil being pumped is of merchantable quality and sufficient flow rate exists, the working level in the surge tank will be pumped down to the lower float switch. Actuation of this switch shuts down the pump and the normal surge tank fill cycle again is repeated.

Generating equipment. Electrical power supply for the battery is furnished by two 10 KW electric generators, each driven by a natural gas engine. Generators are operated on a rotative basis, each being run 24 hours and shut down for the same period of time. Generators are equipped with a control panel for switching the sets from an operating to a standby status. The panel is so wired that should the operating generator fail due to mechanical engine trouble, the standby

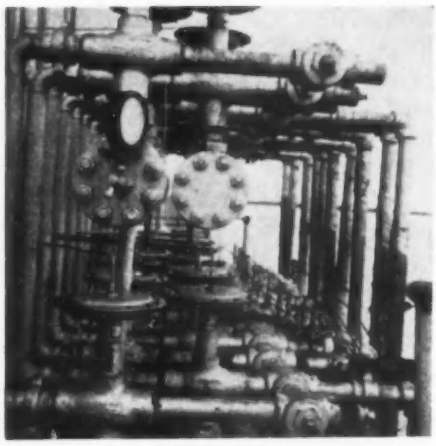


FIGURE 5—Solenoid operated three way motor valves are installed on the inlet manifold so that each well can be switched automatically to the test separator by the programer.

set will start automatically and pick up the electrical load.

Automatic well test. The well test system consists of a 30-well capacity, wall mounted electric well test panel equipped with a data print-out recorder for all necessary test information. Wells can be selectively sequenced for testing with the test duration period ranging up to 30 hours per test.

The programer initiates the well test by switching the well from production to test separator. This is accomplished by the operation of a solenoid operated 3-way motor valve installed on the well inlet manifold (Figure 5). After the well goes on test, the programer delays the sampling during the two-barrel dump separator purge period. This purge period is required to flush the separator of any well fluid remaining from a previous test. Upon completion of test, the programer reroutes the well to its respective production separator. The programer is equipped with a manual selector switch, used for manual testing of any well in any sequence preferred.

A bellows-type integrating orifice meter is utilized for gas measurement during well tests. The integrator is geared to emit a pneumatic pulse each 100 cubic feet of gas. This air pulse is converted into an electrical signal which provides a means of volume transmission to the data recorder.

OPERATIONAL DIFFICULTIES

Immediately following completion of the final installation, some mechanical difficulties were experienced with the float control switches. Float switches were selected for compactness, neat appearance and the adaptibility of the instrument to the subject installation. The particular disadvantage of the instrument, which was not known at the time of installation, was that a fixed frequency power supply with variations not greater than 0.2 of one cycle per second be maintained for successful operation of the instrument.

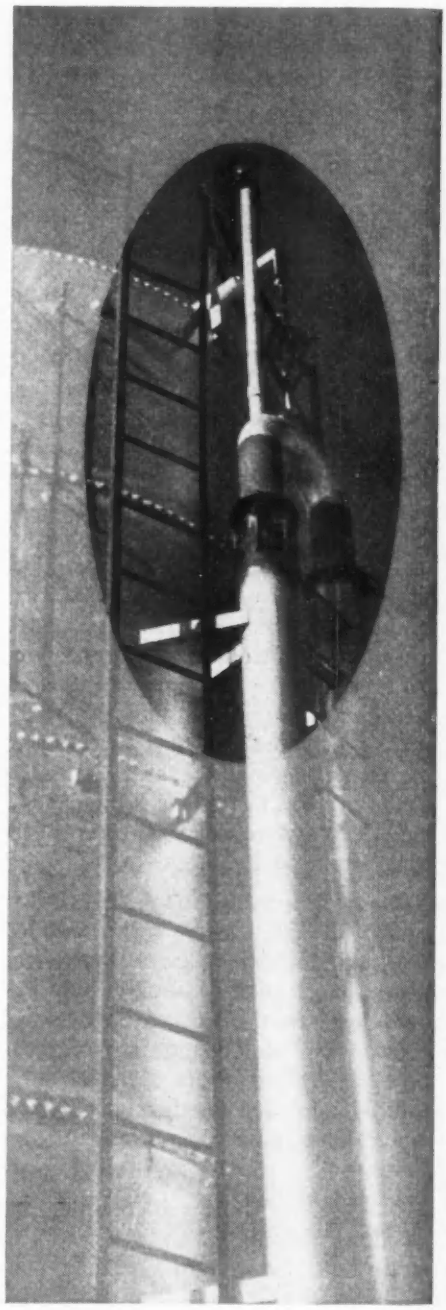
A power supply with frequency control of this nature could not be furnished by an engine-driven generator set. Thus, instruments suffered excessive fatigue and subsequent failure. Instruments were readily repaired and the problem resolved with the installation of a fixed frequency "power pack" supplying power to the circuit containing the float control switches. Other than the aforementioned failures, there have been no difficulties encountered of a major nature.

CONCLUSIONS

This automatic tank battery installation has proven that the employment of automation and custody transfer systems is a possible solution to the reduction of operational and investment costs of production facilities. It is evident that this type installation has a decided economic attraction over conventional type facilities in marine operations where working space is such a costly item. This is especially true when large thruput volumes are anticipated. —**The End**

About the Author

R. H. Peacock is an area staff engineer in Gulf Oil Corporation's Delta Area office, New Orleans. He joined Gulf in February 1952, and since that date has worked in several of Gulf's areas. He was graduated from The University of Texas in January 1952, with a B.S. degree in petroleum engineering.



Fast, easy way to clean a treater water leg

A turnbuckle hookup at top of the treater saves time when scale must be removed from the water leg. The U-bend at the top of the leg can be disconnected quickly by releasing the retaining bolts.

The turnbuckle is then used to raise the U-bend. The pivoted arm on top of the vessel swings it to one side. The leg can then be cleaned—chemically or mechanically—without using a gin pole truck or other hoisting equipment. Crossbars on the water leg serve as steps for personnel doing the work.

How to maintain maximum hydraulic horsepower at the bit

Circulation system must be evaluated thoroughly for efficient drilling practices

By George Boudreaux, District Engineer
Tennessee Gas and Oil Company
Lafayette, La.

THE DEVELOPMENT of modern drilling practices aimed at increasing penetration rates has created the need for a closer look at the hydraulic system of a drilling rig.

In studying hydraulics for penetration rate, two factors must be considered.

- The hydraulic horsepower at the bit must be able to remove immediately each chip as it is cut by the bit to prevent the regrinding of cuttings. If regrinding occurs, penetration rate and bit footage will decrease.
- The circulation rate or annular velocity must be sufficient to carry cuttings from the hole.

Annular velocity. Annular velocity required for carrying cuttings is a variable. First, actual hole size—due to washouts, etc.—is unknown, and annular velocity can only be estimated. Density of the mud, plastic viscosity, and yield point all affect the cutting carrying capacity. Generally, however, the heavier the mud, the less annular velocity is needed to carry the cuttings due to the mud density approaching the density of the cuttings which tend to float the chips out of the hole. For the purpose of this discussion, a minimum annular velocity of 100 feet per minute is used. From field experience, this value has proven to be adequate in most cases.

Bit horsepower. Pumping rate and bit nozzle program are basic factors affecting bit performance. The potential drilling rate is governed by the nature of the action of the bit teeth, depth of tooth penetration, and the effect of the fluid properties (density, viscosity and filtration) on the volume of dislodged formation. The actual drilling rate and bit footage then is controlled by the percentage

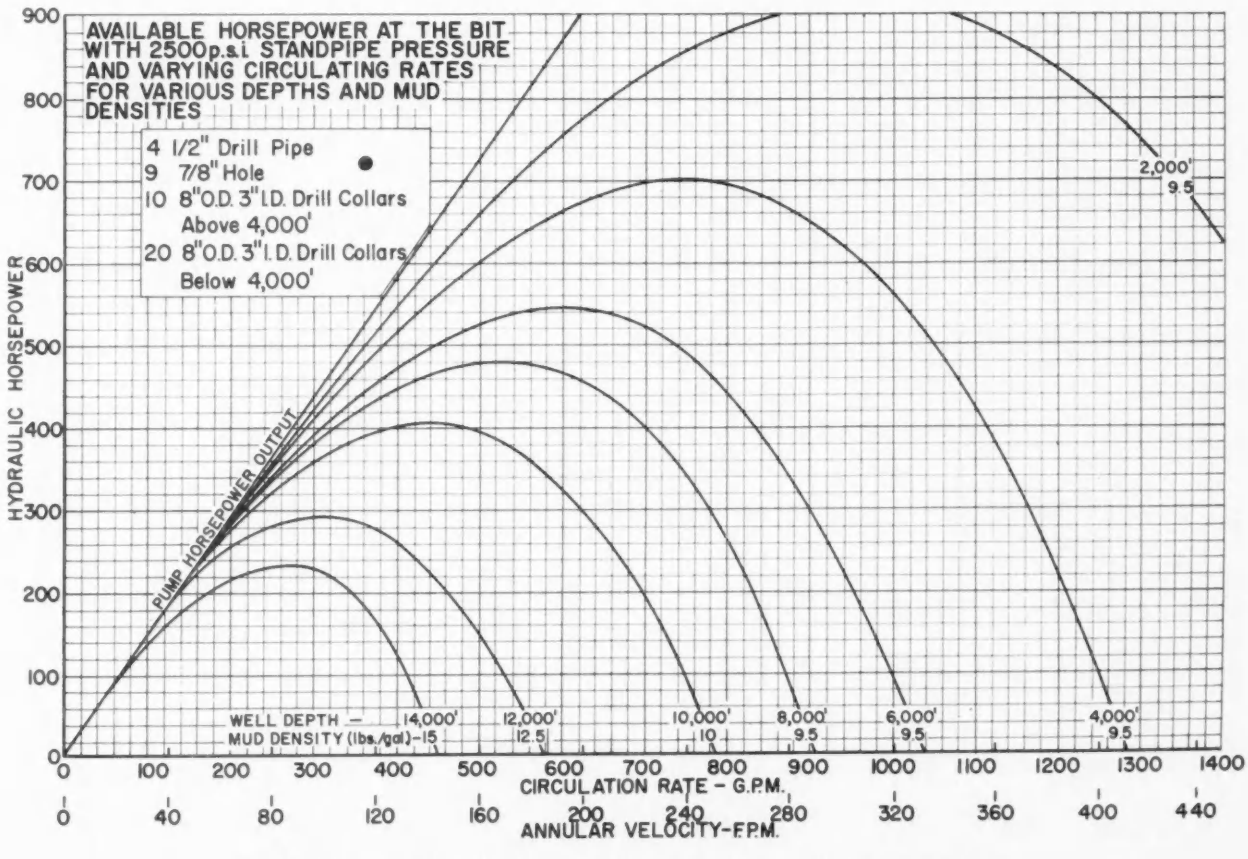

AVAILABLE HORSEPOWER AT THE BIT WITH 2500 p.s.i. STANDPIPE PRESSURE AND VARYING CIRCULATING RATES FOR VARIOUS DEPTHS AND MUD DENSITIES
4 1/2" Drill Pipe
9 7/8" Hole
10 8" O.D. 3" I.D. Drill Collars Above 4,000'
20 8" O.D. 3" I.D. Drill Collars Below 4,000'
HYDRAULIC HORSEPOWER
PUMP HORSEPOWER OUTPUT
2,000' 9.5
WELL DEPTH — 14,000' 12,000' 10,000' 8,000' 6,000' 4,000'
MUD DENSITY (lbs./gal.)–15 12.5 10 9.5 9.5 9.5
CIRCULATION RATE – G.P.M.
ANNULAR VELOCITY-F.P.M.

FIGURE 1—Hydraulic data for 9⅞-inch hole and 4½-inch drill pipe.

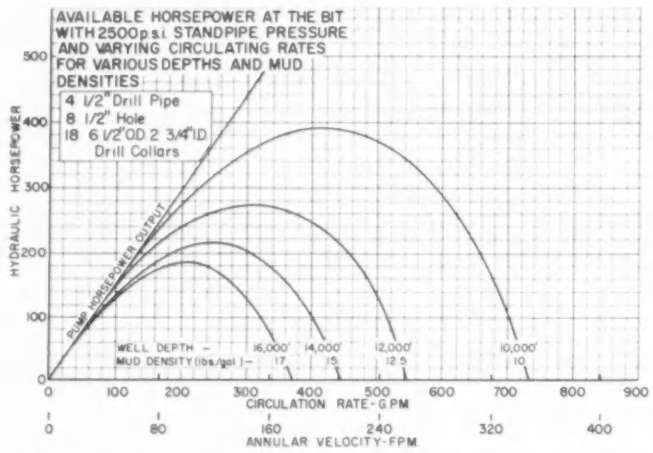


FIGURE 2—Hydraulic data for 8½-inch hole and 4½-inch drill pipe.

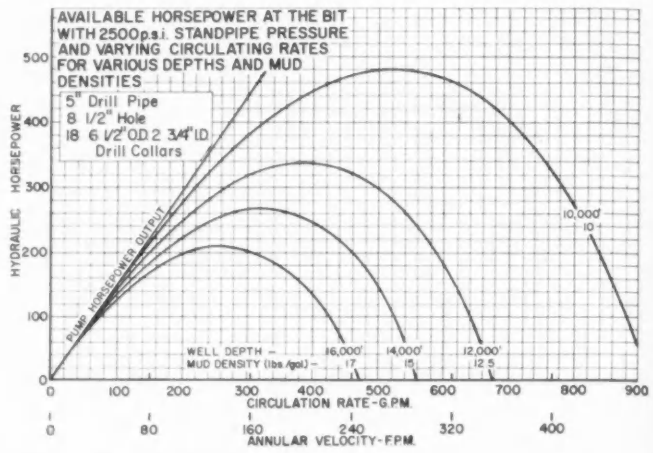


FIGURE 3—Hydraulic data for 8½-inch hole and 5-inch drill pipe.

of this total dislodged rock that can be removed by the drilling fluid before being reground by the bit.

Two theories have been advanced to explain the relationship of circulation rate and nozzle velocity to chip cleaning or particle removal. One group of investigators maintains that the attainable rate of penetration will vary with the impact produced at the bit nozzle, or to the product $Q_n V_n$. Others maintain that the horsepower expenditure of the jet stream below the bit, which is proportional to $\frac{w V^2}{2_g}$ or QV^2, controls the effectiveness of the cleaning action.

Although impact and bit horsepower are the two terms currently used to designate cleaning ability, other factors, such as the type and size of bit, nozzle shape and position, and properties of the drilling fluid, also influence the chip removal by the fluid stream. When maintaining maximum jet horsepower with maximum pump output, the bit nozzle velocity always will be as high or higher than when operating at maximum bit impact. However, circulating rates always will be equal to or lower than those for maximum impact operations. This report treats the effects of jet action in terms of horsepower, while recognizing that it is only that percent of the total bit energy scouring the bottom hole surface which contributes to chip removal.

When considering horsepower, the economics of delivering maximum energy to the bit must be considered. Naturally, the higher the pump pressure, the higher the horsepower that can be delivered to the bottom of the

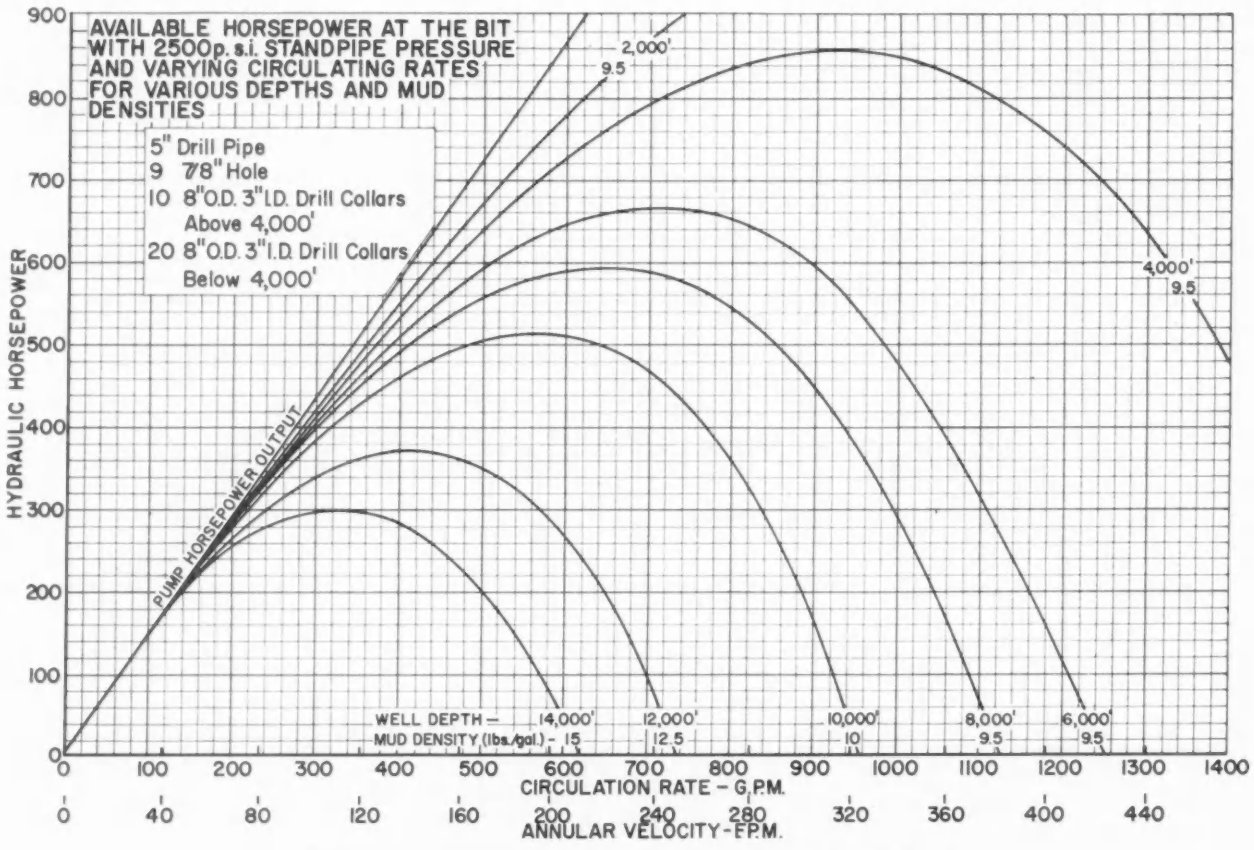


FIGURE 4—Hydraulic data for 9⅞-inch hole and 5-inch drill pipe.

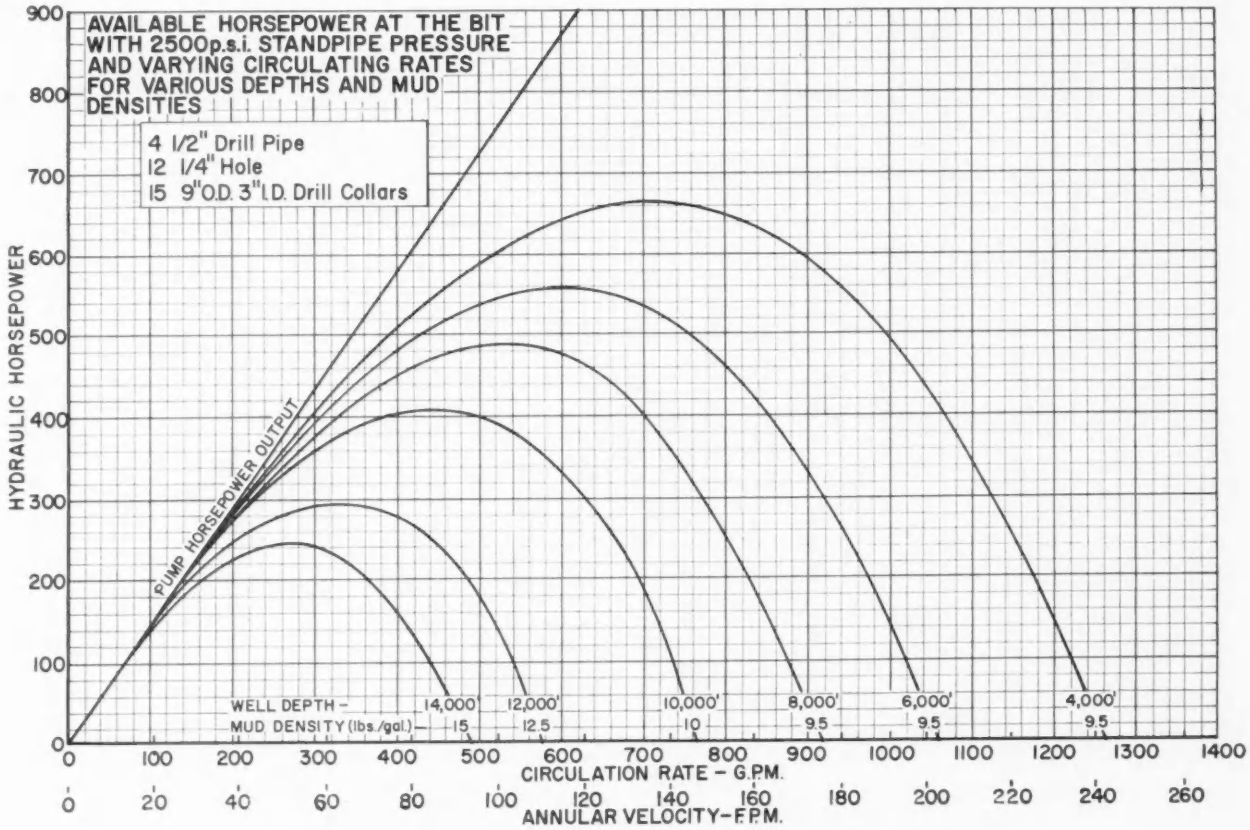


FIGURE 5—Hydraulic data for 12¼-inch hole and 4½-inch drill pipe.

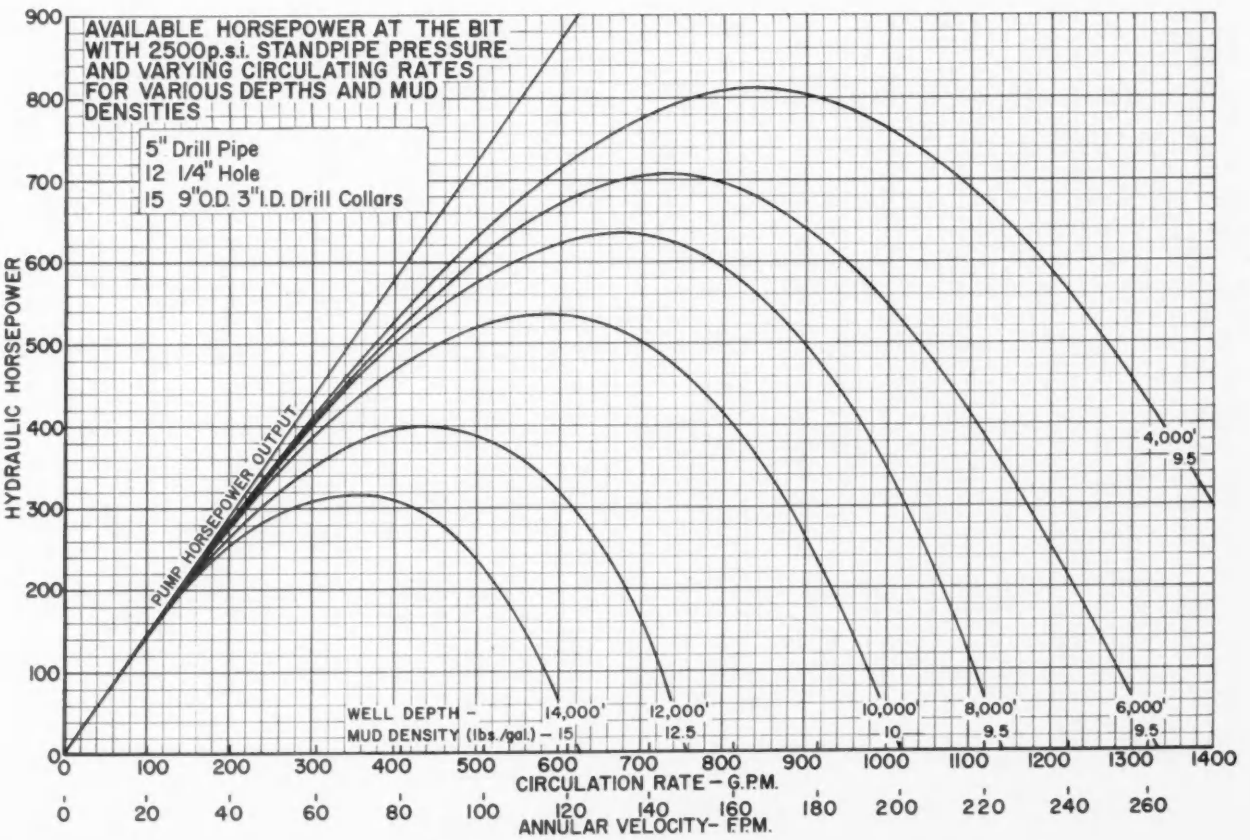
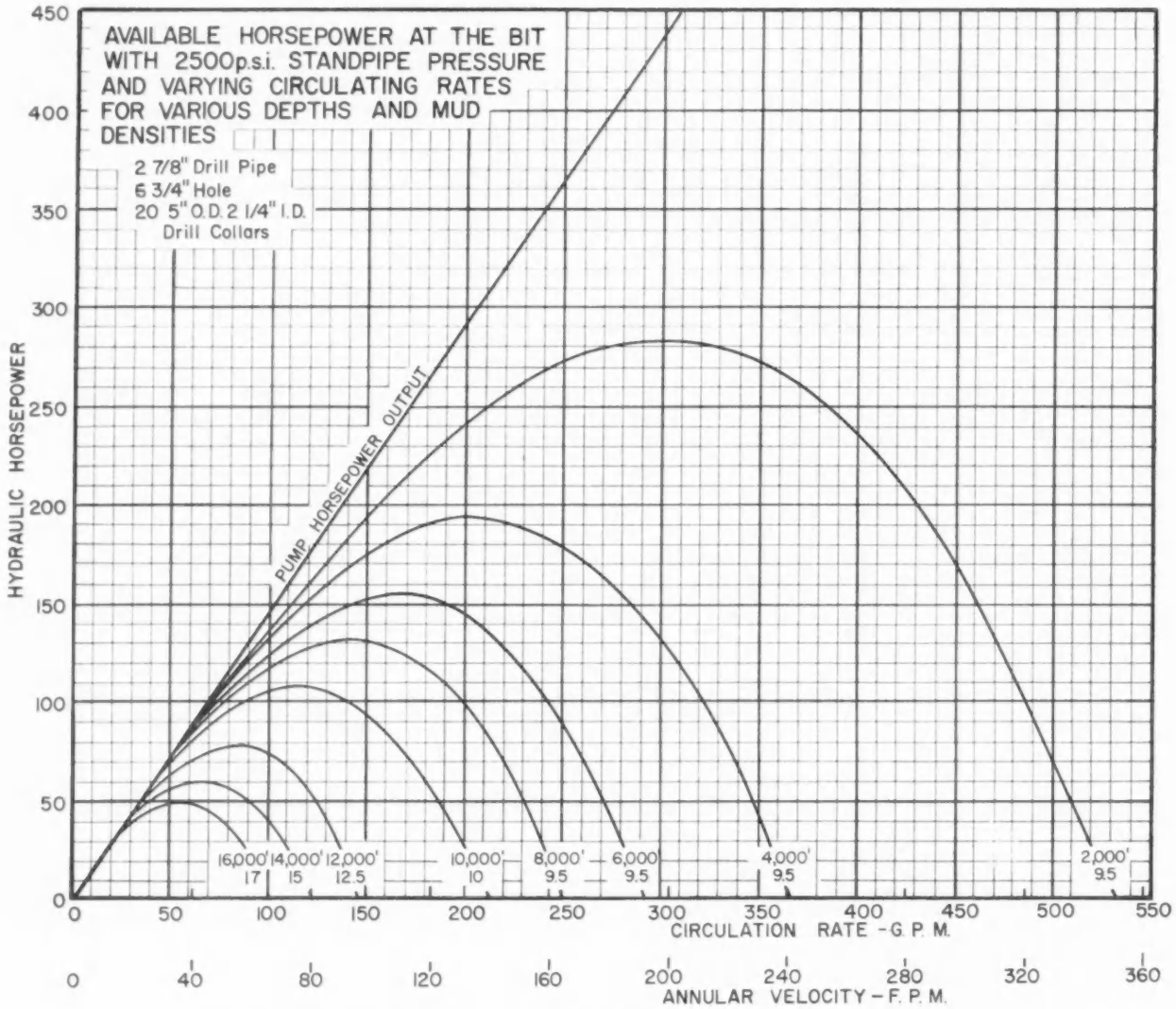


FIGURE 6—Hydraulic data for 12¼-inch hole and 5-inch drill pipe.


AVAILABLE HORSEPOWER AT THE BIT WITH 2500p.s.i. STANDPIPE PRESSURE AND VARYING CIRCULATING RATES FOR VARIOUS DEPTHS AND MUD DENSITIES
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HYDRAULIC HORSEPOWER
PUMP HORSEPOWER OUTPUT
16,000' 17
14,000' 15
12,000' 12.5
10,000' 10
8,000' 9.5
6,000' 9.5
4,000' 9.5
2,000' 9.5
CIRCULATION RATE - G. P. M.
ANNULAR VELOCITY - F. P. M.

FIGURE 7—Hydraulic data for 6¾-inch hole and 2⅞-inch drill pipe.

hole. But, present rig equipment, such as the pump and kelly swivel, limits the maximum continuous operating pressure that can be used without increasing maintenance costs to exorbitant proportions.

Standpipe pressure of 2,500 psi have been used in the Gulf Coast with little resulting increase in maintenance cost, and that is the figure used in this discussion. Other areas might require lower operating pressures. It should be understood that this value is only used to illustrate a method of obtaining maximum horsepower at the bit with present rig equipment and that the future might necessitate making changes in equipment design to withstand higher operating pressures, particularly in slim hole drilling.

Jet bit principles with constant pump discharge pressure. The condition for maximum horsepower expenditure across the bit nozzles may be approximated by assuming that all flow throughout the circulatory system is turbulent. Thence:

Total pump hp = Bit hp + hp loss in system

$$HP_T = \frac{(GPM)\ P_d}{1714} = HP_{Bit} + \frac{K\ (GPM)^{2.84}}{1714}$$

P_d = Pump discharge pressure psi

Where $K\ (GPM)^{1.84}$ = Pressure loss in drill pipe and rest of system exclusive of loss through bit $= P_{d.p.}$

Therefore

$$HP_{Bit} = \frac{(GPM)\ P_d}{1714} - \frac{K\ (GPM)^{2.84}}{1714}$$

For maximum conditions, with P_T constant,

$$\frac{d(HP_{Bit})}{d\ (GPM)} = \frac{P_d}{1714} - \frac{2.84\ K(GPM)^{1.84}}{1714} = 0$$

Whence $P_d = 2.84\ K(GPM)^{1.84} = 2.84\ P_{d.p.}$

$P_{d.p.} = .35\ P_d$

or $P_{Jets} = .65\ P_d$ or when: Bit hp = .65 total pump

Hence, maximum horsepower across the bit jets in a system of limited or constant pressure will occur when the pressure drop across the nozzles is 65 percent of the total pressure loss in the system. This remains true provided the major portion of the total pressure loss results from turbulent flow.

Figure 1 is an illustration of this principle. This graph has hydraulic horsepower plotted against circulation rate. The conditions are: 2,500 psi standpipe pressure, 4½-inch drill pipe, 9⅞-inch hole, 20 3-inch ID x 8-inch OD drill collars, 10,000-foot depth, and 10 ppg mud.

Since the standpipe pressure is held constant at 2,500

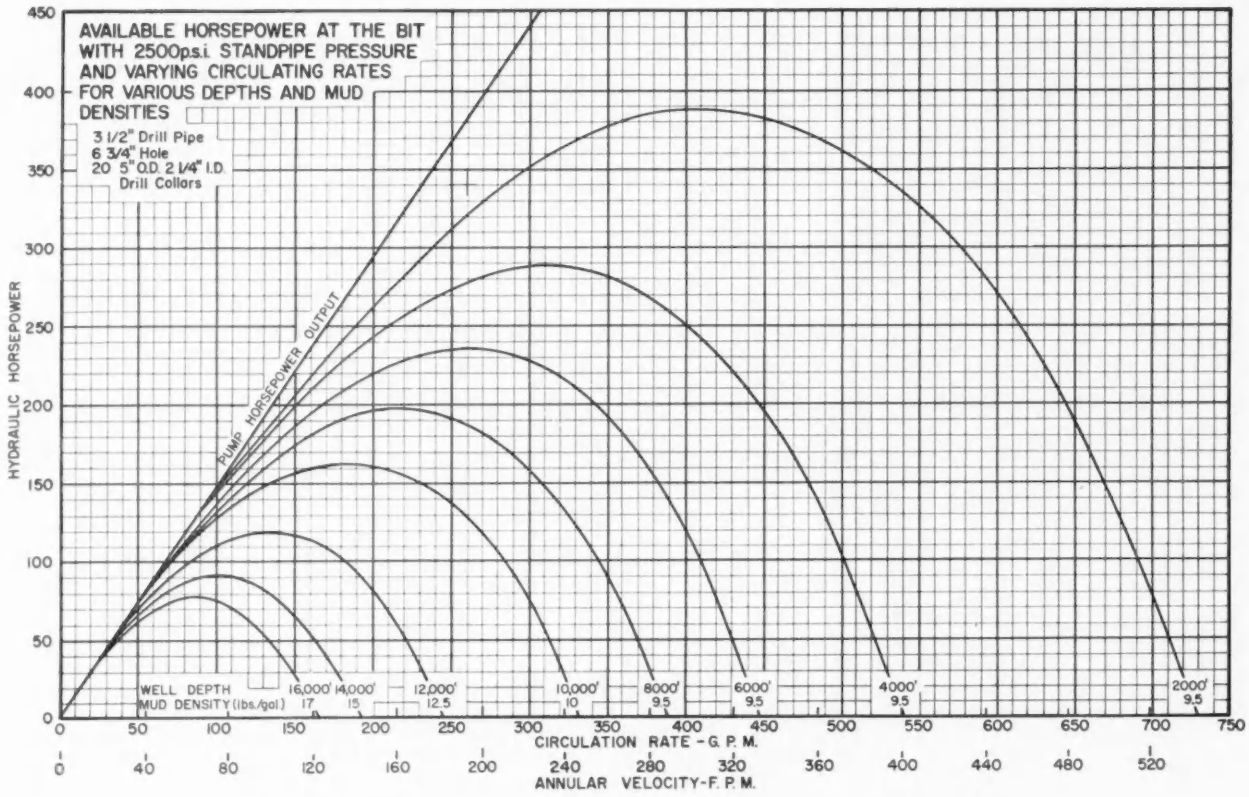

FIGURE 8—Hydraulic data for 6¾-inch hole and 3½-inch drill pipe.

psi and $HP = \frac{\text{Pressure x GPM}}{1714}$, the pump horsepower output is a straight line function as shown in the graph. The curved line represents the hydraulic horsepower available at the bit for various circulation rates. The distance from the curved line to the pump horsepower output for a given circulation rate represents the energy loss in the system excluding the bit.

To operate at 2,500 psi standpipe pressure with a conventional bit, a circulation rate of 785 gpm is required. Naturally, this is an absurd operating condition since all the horsepower is lost in the circulatory system with no energy left for the bit. By changing to jet bits, however, and cutting back on the circulation rate, it can be seen in Figure 1 that more horsepower can be made available at the bit until a maximum is reached at about 430 gpm. At this circulation rate, annular velocity is adequate and 405 of the total 620 hp is available for use at the bit. A further decrease in circulation rate and bit nozzle size for a constant pressure of 2,500 psi will result in less energy at the bit and will approach the critical range of annular velocity.

Figures 2 through 8 present similar curves for various conditions of depths, hole and pipe sizes, mud density, and constant standpipe pressure of 2,500 psi.

Figure 2 presents the hydraulic data for 8½-inch hole and 4½-inch drill pipe and **Figure 3** for 5-inch drill pipe. Each set of curves is for certain depths and mud densities with the densities approximating Gulf Coast practices. It can be seen that there is no problem in obtaining maximum bit horsepower from 10,000 feet to 16,000 feet, with a standpipe pressure of 2,500 psi. Field experience has shown this to be adequate for cleaning the hole at the present penetration rates. However, it should be understood that hydraulics are merely adjuncts to the basic factors which affect bit performance, and that any improvements in bit design, fluid properties, and increase in bit weight or rotary speed in the future may require a re-evaluation of the bit horsepower requirements.

Figures 1 and 4 show hydraulic data for 9⅞-inch hole and 4½-inch and 5-inch drill pipe, respectively. From 6,000 feet to 12,000 feet, the 9⅞-inch hole also presents very little problem in obtaining maximum bit horsepower with a standpipe pressure of 2,500 psi. But extremely shallow depths would require pump requirements above 1,000 hp. This is not deemed necessary since shallow drilling in the Gulf Coast area already is about as fast as the drilling crews can operate efficiently. Therefore, it would be possible to operate at the 1,000 hp limit at the shallow depths without sacrificing drilling rate.

At depths below 12,000 feet with 4½-inch drill pipe, annular velocity becomes the limiting value for available bit horsepower. It, therefore, becomes necessary to operate at less than maximum bit horsepower, although in this particular case at 14,000 feet there would only be a difference of 10 hp.

However, Figure 4 for 5-inch drill pipe shows to some extent one of the advantages of having larger drill pipe for the 9⅞-inch hole. In this case, it is possible to drill below 14,000 feet with maximum bit horsepower before reaching the limiting value of annular velocity.

The 12¼-inch hole presents the greatest challenge to the problem of obtaining adequate hydraulics. Due to the size of the hole, **Figure 5** for 4½-inch drill pipe shows that at 8,000 feet, the annular velocity becomes the limiting value. It also can be seen that at 12,000-feet only 140 hp would be available at the bit out of a total pump horsepower output of approximately 750.

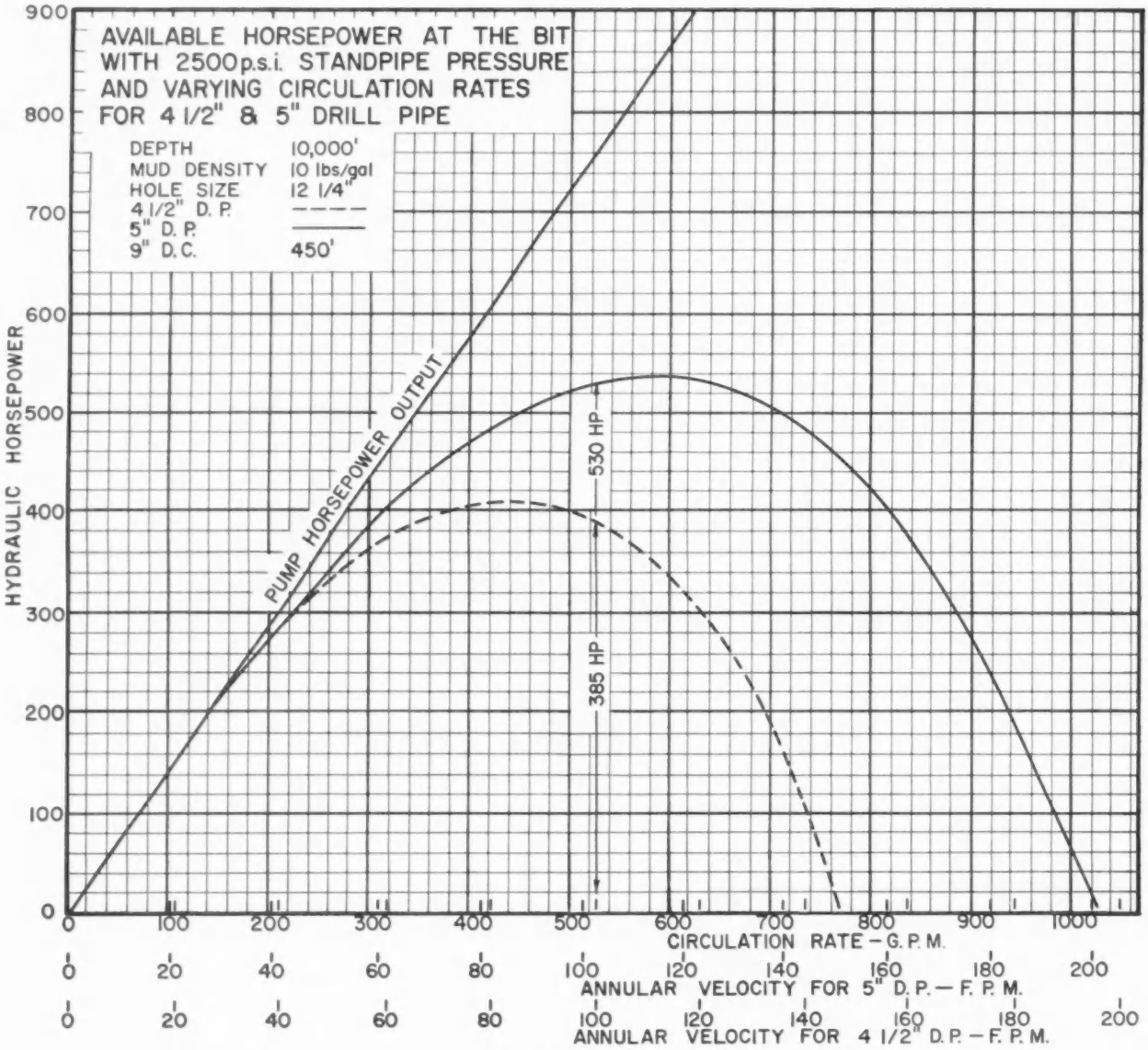
AVAILABLE HORSEPOWER AT THE BIT
WITH 2500p.s.i. STANDPIPE PRESSURE
AND VARYING CIRCULATION RATES
FOR 4 1/2" & 5" DRILL PIPE
DEPTH 10,000'
MUD DENSITY 10 lbs/gal
HOLE SIZE 12 1/4"
4 1/2" D. P. - - - -
5" D. P. ——
9" D.C. 450'
HYDRAULIC HORSEPOWER
PUMP HORSEPOWER OUTPUT
530 HP
385 HP
CIRCULATION RATE – G. P. M.
ANNULAR VELOCITY FOR 5" D. P. – F. P. M.
ANNULAR VELOCITY FOR 4 1/2" D. P. – F. P. M.

FIGURE 9—Available horsepower at the bit while using 4½-inch drill pipe versus 5-inch drill pipe.

It is in this hole size that 5-inch drill pipe becomes almost a necessity below 8,000 feet. **Figure 6** for 5-inch drill pipe shows that at 12,000 feet, 380 hp would be available at the bit out of a total pump horsepower output of 730. This is almost three times the energy available with 4½-inch drill pipe.

Figures 7 and 8 present hydraulic data for the 6¾-inch hole and 2⅞-inch and 3½-inch drill pipe, respectively. The advent of smaller casing sizes and casingless completion practices will require a closer look at slim hole drilling in the future.

Figure 7 for 2⅞-inch drill pipe shows there is little energy available to the bit below 10,000 feet. The 3½-inch drill pipe shown in Figure 8 is an improvement for the deeper depths but still lacks the necessary bit energy to sustain high penetration rates. Three drilling techniques are used to correct this situation:

- Tapered strings
- Higher operating standpipe pressures above 2,500 psi
- Light weight drill pipe with subsequent larger I.D. to lessen the friction loss inside the drill pipe.

The advantages of 5-inch drill pipe over 4½-inch have been mentioned. **Figure 9** emphasizes these points. The dotted curve represents the 4½-inch drill pipe with 15 9-inch drill collars in a 12¼-inch hole at 10,000 foot depth with 10 ppg mud and 2,500 psi standpipe pressure. The solid line curve represents the 5-inch drill pipe under the same conditions.

The available bit horsepower in the 4½-inch drill pipe in Figure 10 is limited by the annular velocity. For example, at 100 feet per minute or 525 gpm, the available bit horsepower is approximately 385 for a pump horsepower output of 760. For 5-inch drill pipe and the same pump output, energy at the bit would be 530 hp and the annular velocity difference of 145 hp which would make a considerable difference in the bottom hole cleaning effect.

Besides having a large volume of dislodged rock to remove due to the large 12¼-inch hole, there is another reason why maximum energy is necessary. Laboratory tests[1] of submerged jet streams has shown that the flow stream center-line velocity and total kinetic energy decrease rapidly at distances greater than six nozzle diame-

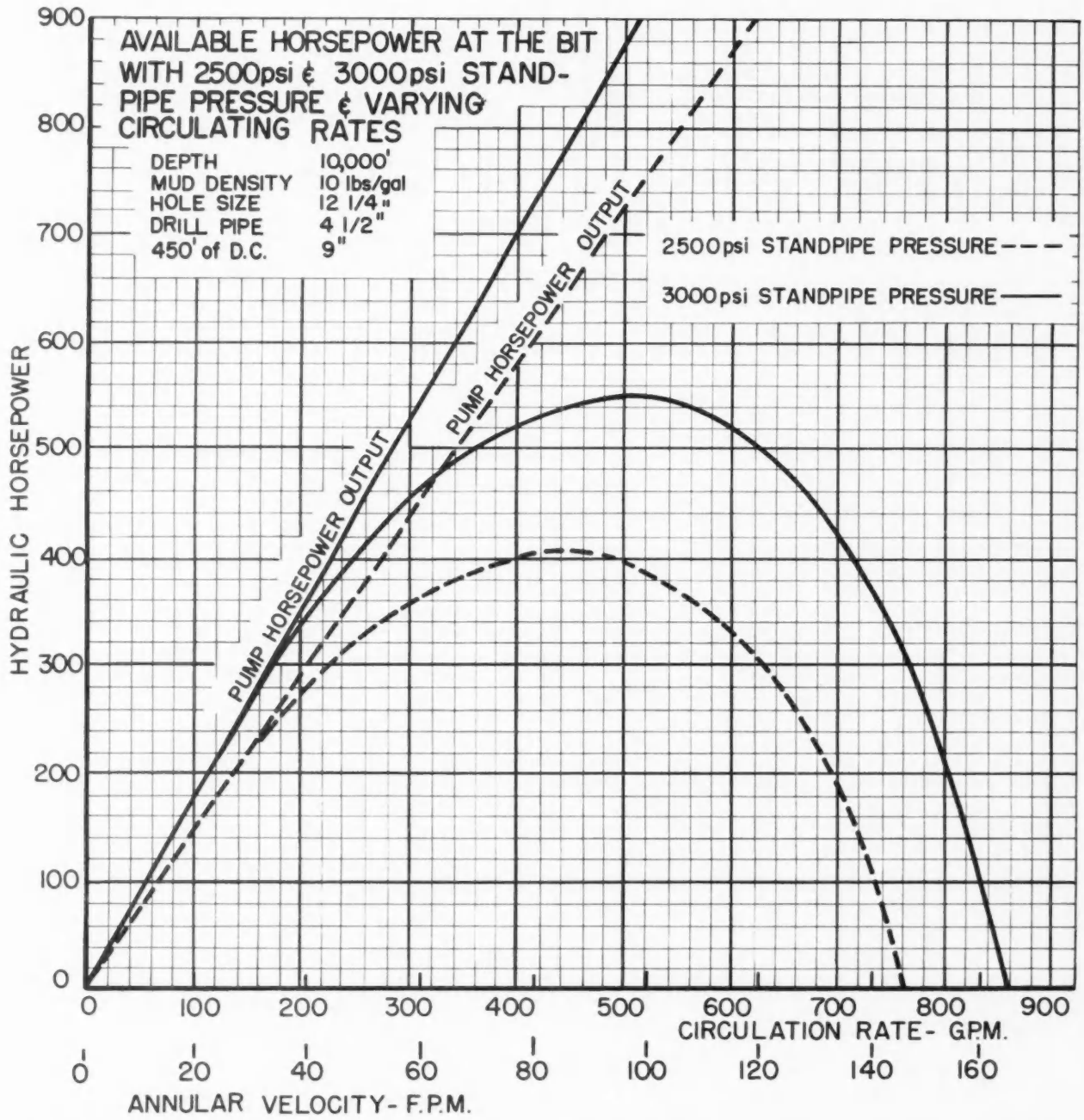

FIGURE 10—Available horsepower at the bit while maintaining standpipe pressure of 2,500 and 3,000 psi and varying circulation rates.

ters from the nozzle exit. Due to the design of a 12¼-inch bit with ½-inch jets, the bottom of the hole is over 12 nozzle diameters away from the nozzle exit. This means some of the energy delivered to the bit in a 12¼-inch hole would be lost between the jet and the bottom of the hole. So, it is imperative that the maximum horsepower possible be delivered to the bit.

Figure 10 shows hydraulic data for 2,500 psi operating standpipe pressure and 3,000 psi. The conditions assumed for the comparison were 12¼-inch hole, 4½-inch drill pipe, 10,000-foot depth, and 10 ppg mud weight. At maximum bit horsepower, the 3,000 psi will produce about 140 more horsepower at the bit than the 2,500 psi standpipe pressure.

About the Author

George S. Boudreaux graduated from Louisiana State University in 1949 with a B.S. in mechanical engineering. He joined Phillips Petroleum Company and held successive jobs as staff engineer, district engineer and division research drilling engineer at which time this article was written. In June 1959, he joined Tennessee Gas and Oil Company and is presently district engineer in the Lafayette district.

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ACKNOWLEDGMENT

This article was prepared while the author was employed by Phillips Petroleum Company as a drilling engineer.

How to predict sand erosion perforating performance

Major considerations include power supplied to the jet, formation hardness and perforation size

By Robert W. Brown, Research Supervisor
Jack L. Loper, Senior Engineer
Westco Research—Division of the Western Co., Dallas

RECENT WORK CORRELATING THEORY and practical experience has confirmed that sand erosion perforating performance *can* be predicted. It was found that maximum penetration resulted when:

- Maximum power is delivered to the jet.
- The formation is permeable, vuggy, relatively soft or fractures
- The casing perforation is enlarged or slotted to reduce power losses within the cavity
- Stand-off distances of about ½ inch are used
- Sand concentrations are maintained at 1-2 ppg. (Larger sand grains produce better results; however, care should be taken to insure that diameter of sand grains is not larger than ⅓ the diameter of the nozzle). Field experience has confirmed these limits as optimum and best results are obtained when they are used.

The sand erosion process involves pumping a liquid containing abrasive solids through a set of nozzles under a high differential pressure. These particles, upon impact with the formation face or casing wall, erode a cavity into the target material.

Rapid progress has been made in perfecting the equipment and techniques used to perform the service. The process now is used for a variety of perforating applications including the single entry, conventional, fracture initiation and directional.[1]

Sand erosion perforating performance is difficult to establish experimentally due to the number of independent, influencing factors which must be considered. For example, performance is dependent upon:

- Power or velocity supplied to the jet
- Type, size and concentration of abrasive material
- Physical properties of the target
- Conditions under which the spent perforating fluid must re-enter the well bore
- Amount of this fluid that is dispersed or lost into the target.

Because of these many variables, an attempt was made to predict the perforating performance from a theoretical view and then substantiate these findings with experimental data. The following discussion briefly describes this study and presents results obtained.

THEORY

The most common criteria of performance for any type of perforating is penetration depth, entry hole diameter and flow index. With the sand erosion process the diameter of the entry hole can be controlled, within certain limitations, to any desirable value. Also, no formation damage occurs. Thus the penetration depth is the only factor which must be established to determine performance.

Since it was impractical to attempt to establish the parameter of penetration from experimental data alone, a limited number of controlled penetration tests were conducted on given targets. Data then were correlated to theory.

The analysis was originally based on power or energy equations. However, the velocity of a jet at a given point is proportional to the power contained within the jet at that point. Also, velocity equations are more commonly understood. Thus, the following performance relationship is based on jet velocity and factors affecting it.

In deriving the theoretical relationship, two assumptions were made:

- Jet velocity diminishes with distance due to turbulent diffusion of the jet[2]
- For each particular formation or target there is some minimum velocity below which no measurable erosion of the material will occur. This value is termed the threshold velocity of the material in question.

The following relationships then were derived:[3]

1. **Penetration Into Cased Formations**

$$t = K_v \left[\frac{C_v D \bar{V}_o}{(V_{th} + \Delta V_p)^2} \ln_e \left(\frac{C_v D \bar{V}_o}{C_v D \bar{V}_o - (V_{th} + \Delta V_p) L} \right) - \frac{L}{(V_{th} + \Delta V_p)} \right] \text{Sec.}$$

2. **Penetration Into Open Formations**

$$t = K_v \left[\frac{C_v D \bar{V}_o}{V_{th}^2} \ln_e \left(\frac{C_v D \bar{V}_o}{C_v D \bar{V}_o - V_{th} L} \right) - \frac{L}{V_{th}} \right] \text{Sec.}$$

Where:

C_v	Empirical constant ($C_v = 6.4$), Dimensionless
D	Nozzle Diameter, in., ft.
H	Relative abrasion hardness of material measured on ICT Scale, Dimensionless.
K_v	Constant of proportionality for velocity equations, Dimensionless.
L	Distance measured along jet axis (Penetration), in., ft.
t	Time, sec., hr.
$\bar{V}_o$	Average fluid velocity of the jet at nozzle discharge ($L = O$), ft/sec.
V_{th}	Threshold cutting velocity for a particular material, ft/sec.
ΔV_p	Velocity Loss of jet resulting from flow through perforations and backpressure, ft/sec.

Penetration versus time curves based on equation 2 for open formations are shown in Figure 1. Hardness (H) values are taken from the International Critical Tables for relative abrasion hardness.

These curves indicate minimum penetrations under the given conditions. This is partially because conditions imposed by equations 1 and 2 are more restrictive than actual field conditions.[3] This is exemplified by the experimental data points appearing in Figure 1, and by the actual tests results presented later in the article.

Although all data points do not fall on the theoretical curves, they do follow the same general contour.

Tests on the 5-9 day cement were originally set up to illustrate penetration into a cased target. However, due to cement channeling, results more closely parallel that for open formations. The wide separation between the two sets of data was attributed to variations in degree of channeling. Separation between cement data (5-9 day and 23-100 day) verifies the fact that curing time greatly affects the abrasion hardness of cement.

Limestone data were taken under cased conditions. The target did not fracture and cement did not channel. However, the rock was quite permeable allowing a portion of the spent perforating fluid to leak off into the target. This tends to increase penetration, since the overall effects are the same as enlarging the casing perforation. Either effect tends to reduce power losses within the formation cavity.

A penetration versus time plot is not included for cased formations due to the complex conditions and lack of reliable data required for the determination of ΔV_p. In general, penetration into cased formations is substantially less than penetration into open formations. However, it should be pointed out that penetration into cased formations very closely approximates that in open formations when the casing perforation area is increased to an area equivalent to a two-inch diameter circle.

APPLICATIONS

In actual practice, results obtained from sand erosion perforating have been better than theory would predict. Actual penetration results are impossible to establish accurately from field data alone; however, repeatedly good results have been obtained using the method.[1]

The fact that sand erosion perforating produces good results is evident, but the fact that such results are obtained because of deeper penetration may be subject to question. Penetration in the well cannot be proved, but the following discussion presents some penetrations obtained from surface tests which were conducted under submerged flow conditions.

Limestone target. A penetration of 33 inches was obtained in 23½ minutes pump time. This penetration was measured on a side of the block that did not fracture and cement did not channel. However, the target was quite permeable and a portion of the spent perforating fluid bled off into the pores of the target.

The penetration obtained on this particular test was obtained under cased conditions. Since oil productive formations have at least some degree of permeability, similar results should be expected from actual downhole, through casing, perforating.

Cement target. On this test, 31 inches of penetration was obtained in 15 minutes. The target fractured and allowed the fluid to partially channel the cement around the casing. This allowed a portion of the spent perforating fluid to escape and decreased the volume that was forced to re-enter the well bore through the casing perforation.

Although this target was set up for penetration results under cased conditions, the fracturing produced results more closely paralleling that for open hole conditions.

Cement target—single entry technique. A pancake of approximately 25 inches OD was obtained in 22-minutes pump time. This slotting effect was obtained using a self-propelled rotating tool (Figure 2).

Penetration versus time results are lower using the slotting technique because a greater mass of rock per depth of penetration must be removed. For example, it requires only about 20 seconds to form a single casing perforation, but approximately 100 seconds to completely cut the casing in two.

Normal view of a typical slot. In Figure 3, the slot pinches down to a point at the periphery of the cut. This is advantageous to creation of a stress concentration within the cavity that causes the fracture to propa-

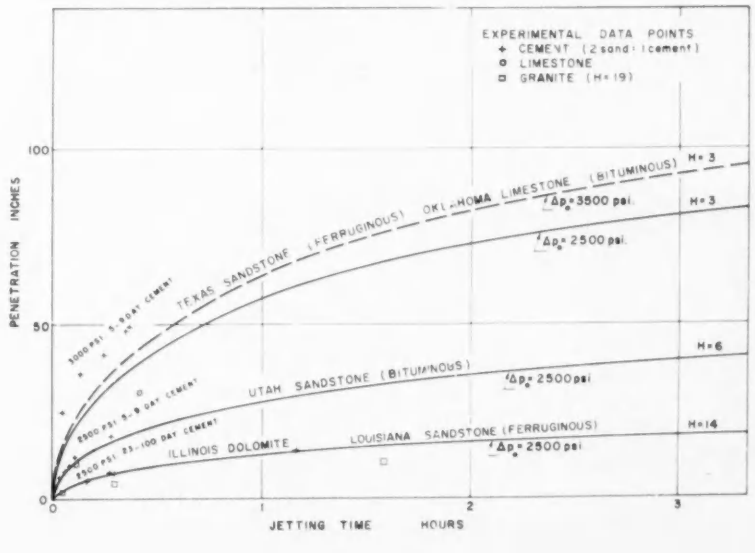

FIGURE 1—Curves show relationship of penetration versus time for formations of various degrees of hardness. The effect of increasing nozzle pressure differential is depicted for a formation of H = 3. Effects of increasing nozzle pressure differential decrease with increasing H values. All tests were conducted under submerged flow conditions using a slurry containing one pound of 20-40 Ottawa sand per gallon of water.

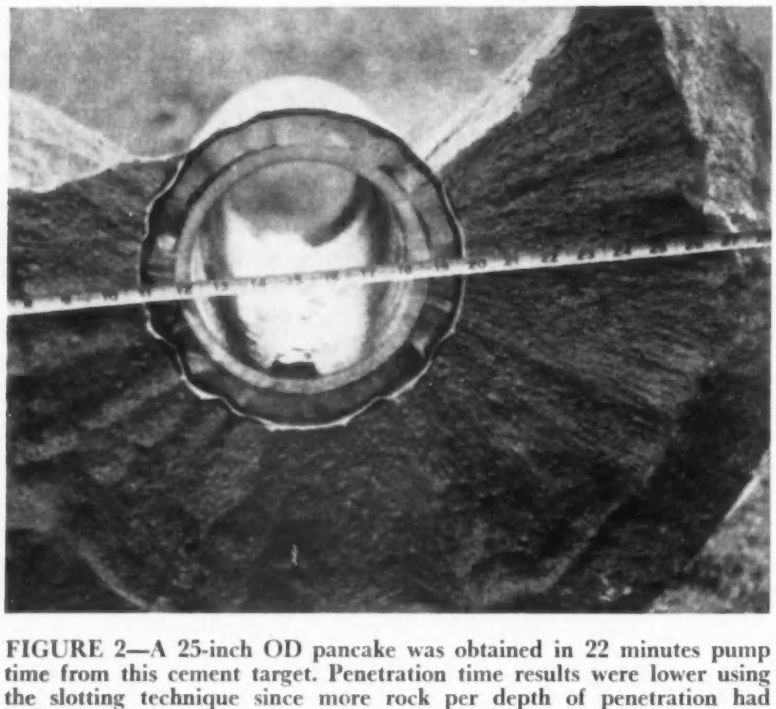

FIGURE 2—A 25-inch OD pancake was obtained in 22 minutes pump time from this cement target. Penetration time results were lower using the slotting technique since more rock per depth of penetration had to be removed.

FIGURE 3—The point at the periphery of this cut is advantageous to creation of a stress concentration within the cavity. This will cause the fracture to propogate in the required direction.

gate in the oriented direction. This slot is not the same one illustrated in Figure 2. The Target shown in Figure 2 split horizontally in a plane emanating from the cut when the outside of the block was struck with a sledge.

The results presented in both Figures 2 and 3, are representative of those obtained under open hole conditions. This is true by virtue of the slot. The slotting effect of the casing and the formation permit the spent fluid to re-enter the well bore without having to oppose the cutting fluid.

Additional tests, not discussed in this article, have yielded similar results.

Conclusions:

Maximum penetration is strongly influenced by:

- Power supplied to the jet
- Formation hardness
- Perforation size—particularly when the well is completed through casing.

Factors which affect performance, but not as significantly as those listed above are:

- Nozzle stand-off distance
- Sand concentration
- Back-pressure.

These factors are placed in this secondary category because stand-off and sand concentrations can be controlled by proper equipment or treatment design. Although back-pressure is not readily controlled, performance reduction caused by this factor approaches a constant value as the absolute magnitude of back-pressure is increased.

Recent studies indicate that the sand erosion process may be readily adapted to the use of air as the sand carrying medium. Air (being compressible) has an advantage over water in that it can be expanded with the use of a convergent-divergent nozzle to much higher velocities. This higher velocity would add additional momentum to the sand particles, thereby tending to increase the penetration.

ACKNOWLEDGMENT

The authors wish to express their appreciation to the management of The Western Company for permission to publish this article.

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About the Authors

Robert Wade Brown has been a research supervisor for Westco Research, a Division of The Western Company, since June, 1960, after having served as a research chemist and as chemical engineering group supervisor in Western's Research Section since February 1956. He holds a B.S. degree in Chemistry and math and a M.S. degree in chemistry from North Texas State College at Denton, Texas. He is a member of Alpha Chi Sigma, the American Chemical Society, AIME, and the Dallas Petroleum Engineers Club.

Brown

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Jack Loper is a senior engineer in the Chemical Engineering group of Westco Research. He received his B.S. degree in mechanical engineering from the University of Alabama and his M.S. degree in mechanical engineering from the Missouri School of Mines and Metallurgy. He is a member of Tau Beta Pi, Pi Tau Sigma, and an associate member of ASME.

Significant gas reserves are a possibility. Prospects for discovery of oil are considered good

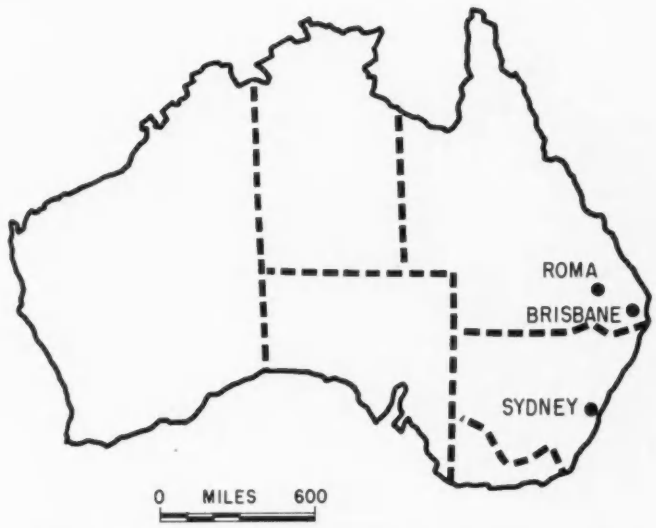

FIGURE 1—Locality map, Roma District, Queensland, showing area covered by current investigations.

Commercial gas is found in Queensland, Australia

By Douglas M. Traves
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Brisbane, Australia

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Geo Prospectors, Inc.
Tulsa, Oklahoma

THE BEST FLOW of petroliferous gas ever recorded in Australia follows a year of re-examination of the oil and gas potential at Roma, Queensland. The well, Pickanjinnie No. 1, flowed at the rate of 6½ million cubic feet a day and refutes the opinion of many Australians, including some geologists, that 57 wells, drilled 20 to 40 years ago without geophysical services and adequate drilling techniques, had thoroughly tested an area of over half a million acres.

Gas was first discovered at Roma early in this century during the deepening process of a town water well. Since then sporadic exploration and drilling have been carried out over a period of 50 years with encouraging, but generally noncommercial results. From 1928 to 1932 oil was produced from a gas absorption plant and was sold locally at Roma. Significant but noncommercial quantities of oil have been recovered from some wells.

In 1959, Mines Administration Pty. Limited, the service company for the titleholders, Associated Australian Oilfields N. L., Associated Freney Oil Fields N. L., and The Papuan Apinaipi Petroleum Company Limited, commenced a re-examination of the area. Re-examination included a detailed seismic survey of a rectangular block approximately 20 miles x 5 miles (See Figure 1). Austral Geo Prospectors Pty. Ltd., a subsidiary of Geo Prospectors, Inc., of Tulsa, conducted the seismic program. Preliminary seismic interpretations suggested that the use of surface geology for anything other than the establishment of general trends had led in the past, and could lead in the future, to wrong conclusions regarding subsurface structure. The presence of major unconformities and complex fracture systems below these unconformities provided a reasonable explanation for the failure of many of the older drill tests of the area.

Two wells were drilled during 1960—Timbury Hills 2 and Pickanjinnie 1—approximately 20 miles apart. The first well, three miles from Roma, produced at the rate of 1½ million cubic feet per day of petroliferous gas through ¼-inch choke. The second well penetrated four gas sands, the combined test of the top two yielding a steady flow of over 6½ million cubic feet per day on a 1-inch choke. Sand pressures were close to normal, 1,650 psi at Timbury Hills and 1,800 psi at Pickanjinnie.

Stratigraphy. Five units of Upper Triassic/Lower Jurassic to Lower Cretaceous age unconformably overlie either Permian sediments or basement, which in this district is taken as granite or the Timbury Hills Formation. The Timbury Hills formation is a fine grained sedimentary unit of unknown age which in places is slightly metamorphosed. A table showing more detailed stratigraphy is outlined by Figure 2.

The age of the Timbury Hills formation may be lower Permian, Carboniferous or Devonian. The age of the granite is not known, although it is believed to be pre-Permian.

The three gas sands encountered to date in the basal Mesozoic unit are—(1) the Hospital Hill Sandstone, approximately 40 feet thick with porous

sands 10 to 20 feet thick, has been the main gas producer to date and it produced over 5½ million cubic feet per day at Pickanjinnie; (2) the Links Sandstone, 10 feet thick, produced 1 million cubic feet of gas in a drill stem test at Pickanjinnie; and (3) the Showground Sandstone, 10 feet thick, produced 25 thousand cubic feet per day at Pickanjinnie.

In the Permian section no porous sands were encountered at Pickanjinnie, but one horizon yielded 10 thousand cubic feet of very wet gas. Oil bleeding cores were obtained from the Permian below the latter horizon.

Seismic traverses indicate thickening of the Permian section east of Pickanjinnie. Similarly, to the north of Roma the Permian section thickens. At a point 60 miles north of Roma at least 5,000 feet of Permian formations were penetrated in an old exploratory drill test.

Figure 3 presents a diagrammatic east-west section of the Roma area.

One point of interest is worthy of mention. Although the entire section dips eastward from Pickanjinnie to Wallumbilla on seismic correlation, spore correlation indicates a rise in the pre-Moolayember erosion surface. It is suspected that highs in this erosion surface are responsible for the cut-out of the basal Mesozoic sand in some places and that possibly there are places where most, if not all, of the Moolayember Formation may be missing.

Folding and faulting have occurred in post-Permian and post-Cretaceous time with, as might be expected, more faulting and folding in the older rocks. In the Mesozoic section, folding appears sympathetic with the older rocks. The faults are small and grade from definite faults with throws of 100 feet or more to sharp monoclinal flexures.

Petroleum Prospects. The concession held jointly by the three companies in which Roma is located covers approximately 30 million acres.

Two seismic structures were drilled in 1960, and gas flow was obtained from each. From what is known of the older tests, it appears that in the immediate vicinity of Roma the permeability of the Hospital Hill Sandstone allows flows of better than 1 million cubic feet per day without treatment. The gas-water or gas-oil contact is not yet known, so that wells

Stratigraphy of the Roma Area

AGE	FORMATION TOP		THICKNESS	LITHOLOGY
Lower Cretaceous	Roma Formation		300–499 ft	Limestone, shale calcareous sandstone
Upper Jurassic	Blythesdale Formation	Transition Member	150 ft.	Limestone, shale calcareous sandstone
		Mooga Member	175–300 ft.	Sandstone
		Fossil Wood Member	200 ft.	Shale and sandstone
		Cubberamunda Member.	350–550 ft.	Sandstone
Lower Jurassic	Walloon Coal Measures		1200–1400 ft.	Shale, minor sandstone, coal
	Bundamba Sandstone		600–750 ft.	Sandstone
Upper Traissic ?	Moolayember Formation		500–700 ft.	Shale, siltstone minor sandstone
Upper Permian	Pickanjinnie Formation		300 ft. +	Shale, siltstone minor sandstone
Upper Permian	Latemore Formation		345 ft.	Shale, siltstone minor sandstone
?	Timbury Hills Formation		550 ft. +	Very fine grained sandstone-siltstone or interbeds.
?	Granite			

FIGURE 2—Stratigraphy of the area under investigation.

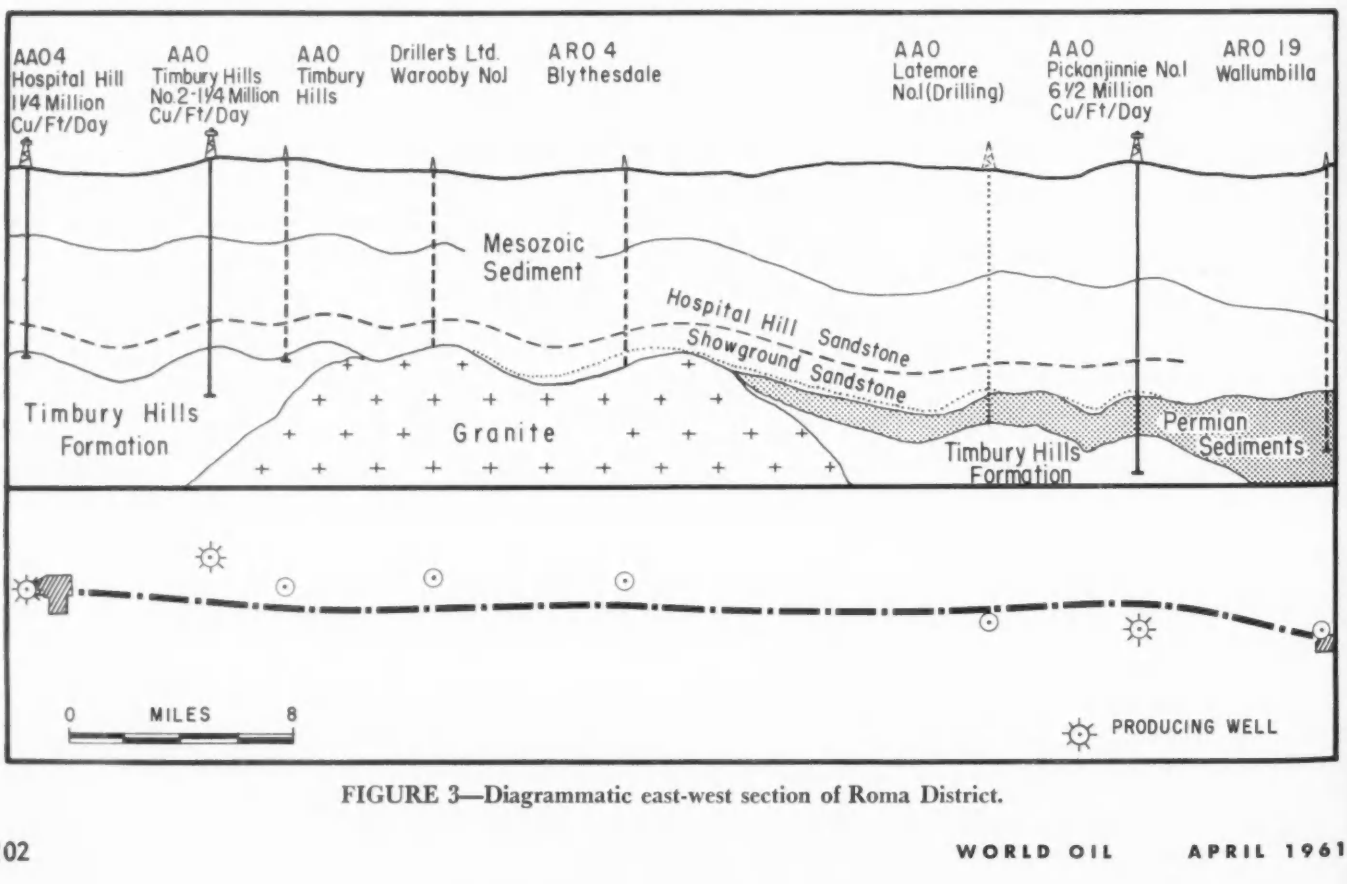


FIGURE 3—Diagrammatic east-west section of Roma District.

FIGURE 4—Rig owned and operated by Mines Administration Pty. Ltd., drilling at Timbury Hills, near Roma. The 30 million-acre concession is characterized by easy terrain and good access by road and rail to nearby centers and Brisbane, the capital city of Queensland. Drilling costs are amongst the lowest in Australia.

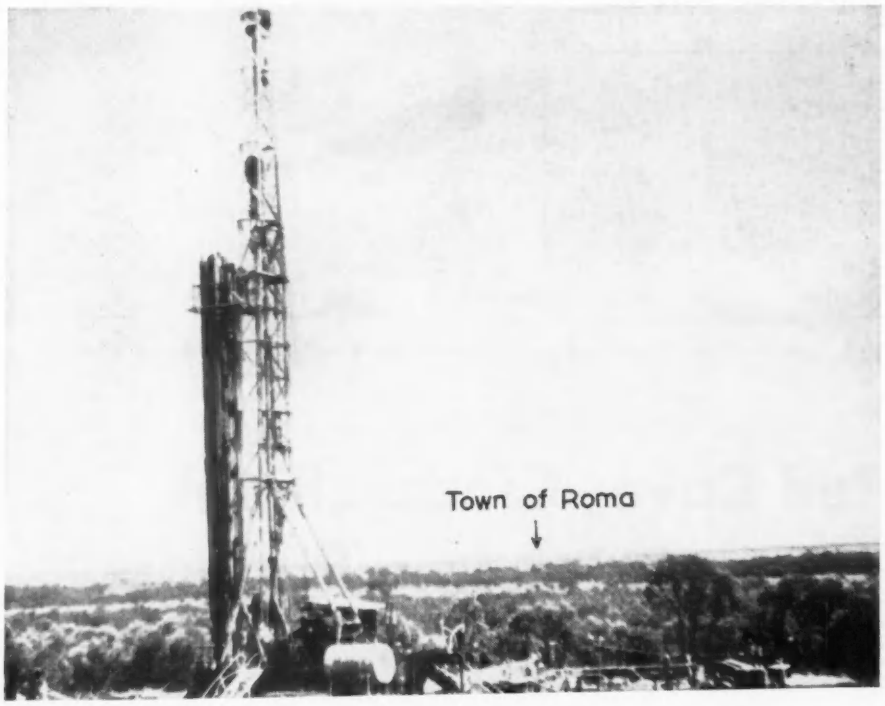


FIGURE 5—Seismic shot hole outfit of Australia Geo Prospectors Pty. Ltd., subsidiary of Geo Prospectors, Inc., of Tulsa, Okla., operating in the Roma concession. The seismic contractors have drilled over 170,000 feet of shot hole in the area in less than 12 working months. Current seismic activities are being directed to the north and south of the 25 miles by five miles block (Figure 1), in an area where the Permian section thickens considerably.

off-structure will be required for evaluation.

It is assumed that the Permian sediments are the source of the gas. But so far they have been recognized and thoroughly examined only in the Pickanjinnie well, where no favorable reservoir beds of Permian age were encountered.

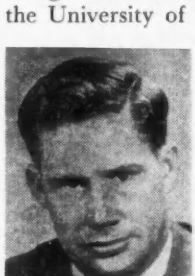
There are numerous structures within the 5 x 20 mile area covered by the original seismic survey. This survey is being extended by current operations towards both the north and south. One or more rigs will be active on a continuous drilling and evaluation program for the next several months. The initial success of the exploratory program, although modest by world standards, is extremely encouraging.

It appears probable that stimulation methods employed in other parts of the world could increase the flow of gas from the reservoirs already tapped. Oil shows encountered in the Permian section and the expected increased thickness of these formations in untested areas leads to the conclusion that the ultimate discovery of commercial oil in the general Roma area is a definite possibility. Development of significant gas reserves appears to be a distinct probability.

—The End

About the Authors

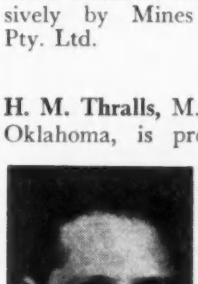
Douglas M. Traves, is a B.Sc. of the University of Queensland. He



joined the Australian Bureau of Mineral Resources in January 1947. Through to 1954 he was engaged in regional geological surveys in Northern and Central Australia. Several of his reports have been published by the Australian government. For a year he was lent to the Pakistan government under the Aid Plan for regional mapping in Azuad Pakistan and Chitral.

Joining Mines Administration Pty. Ltd. (Service company for the Australian group which comprises Associated Australian Oilfields, Associated Freney Oil Fields and Papuan Apinaipi Petroleum) in 1954, he was appointed chief geologist in 1955 and exploration manager in 1960. He is responsible for exploration operations for the group, which holds concessions in western Australia, Northern Territory, Queensland and Papua, and in addition for outside contract work which is carried out extensively by Mines Administration Pty. Ltd.

H. M. Thralls, M.S. University of Oklahoma, is president of Geo



Prospectors, Inc., Tulsa, and Austral Geo Prospectors, Pty. Ltd., Brisbane, Queensland, Australia. His experience in seismic prospecting dates from 1934 and encompasses periods of employment with Shell Oil Company as assistant seismologist and with Seismograph Service Corporation as party chief, supervisor, chief geophysicist, and vice president. Geo Prospectors, Inc., a geophysical contracting firm, was organized by Thralls in 1955.

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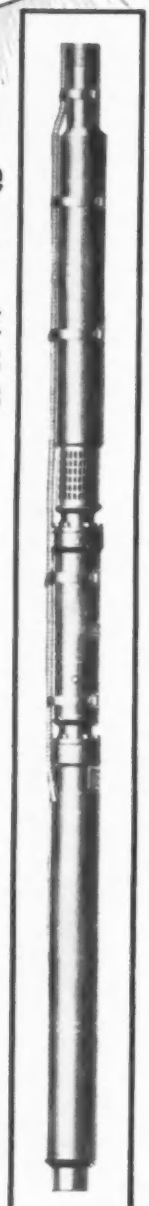

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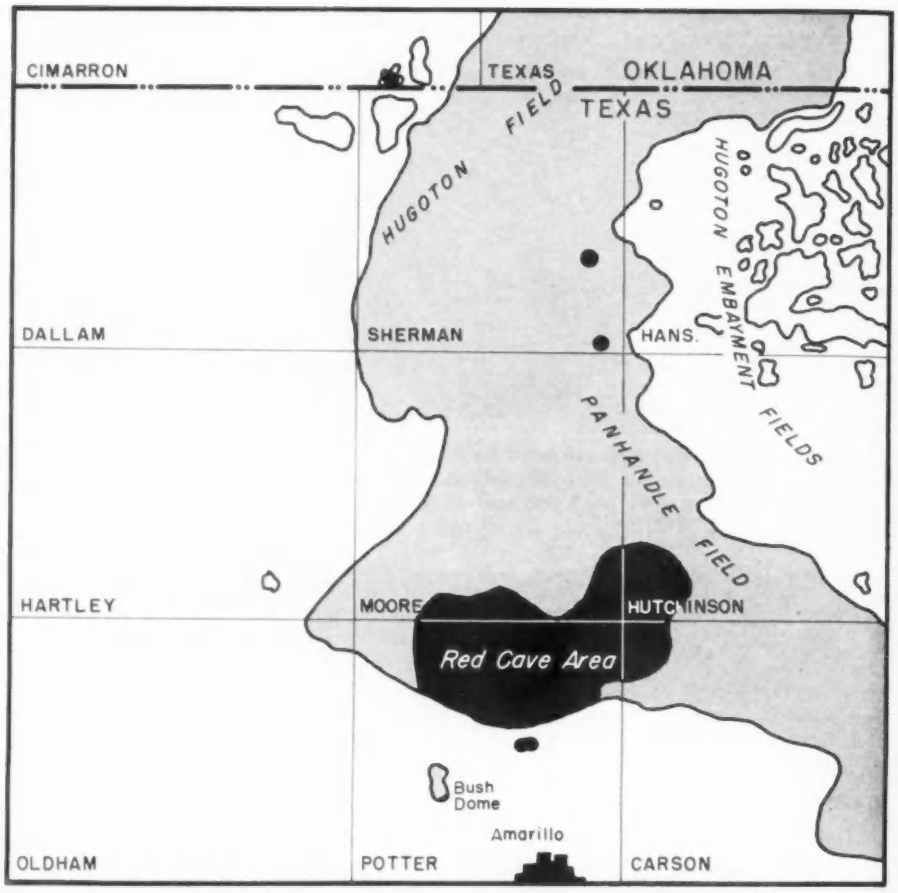

Dark areas indicate Red Cave production in the Texas and Oklahoma Panhandles.

Red Cave—Cinderella of Texas-Oklahoma Panhandles

After 40 years 'under wraps', this shallow horizon is fast becoming a major producer in the world's largest gas field

By Curtis Stevens, Editor
National Petroleum Bibliography,
Amarillo, Texas

IN AN AREA 60 miles wide by 90 miles long, operators in the Texas and Oklahoma Panhandles are seeking the bonus of 40 years' drilling—a shallow gas sand with good reserves, good potentials, and almost virgin pressures.

The Red Cave formation, lower Clearfork group of the Leonard-Permian, has come into its own after being passed by in the drilling of hundreds of wells during the development history of Panhandle field. Seventy producers have been drilled in little more than one year, and the first two months of 1961 saw nearly 20 new tests announced.

Even at this early date, it is reasonable to assume that the Red Cave reservoir eventually will have more than 350 gas wells on a spacing pattern of 640 acres.

Found at depths ranging from 1,400 to 2,700 feet, the new pay is being tapped for gas volumes up to 19 MMcf per day, and chances are that

Red Cave—Cinderella of Texas-Oklahoma Panhandles

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even bigger producers will be completed. Reservoir pressures show little evidence of 40-years penetration.

Covering a semi-proven area of some 225,000 acres, the producing sector is growing in size almost daily. Though bulk of production is concentrated in the old field area of Potter, Carson, Hutchinson and Moore counties in the Texas Panhandle, Red Cave wells have been completed in two other counties, and a total of 11 counties presently is undergoing Red Cave prospecting or evaluation.

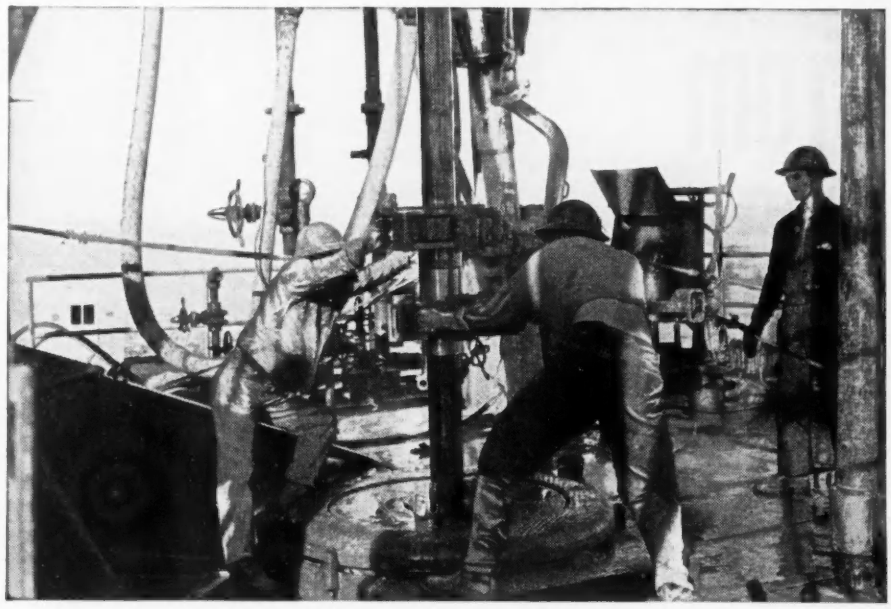
Unique in natural gas history, the Red Cave producing area is the first major reservoir to be opened with gathering and trunkline facilities already in place, and gas markets already established.

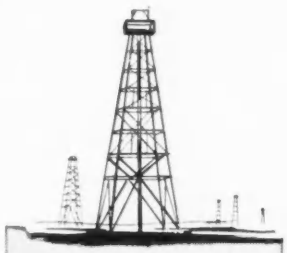
Colorado Interstate sparks play. Prior to 1959, the Red Cave formation was little-known and little-regarded, so much so that well cuttings from the formation are hard to find in area sample libraries.

It was considered an oddity when the Shamrock Oil and Gas Corporation's C. F. Brown 1 was completed as a Red Cave gas producer in April 1959, making calculated flow of one MMcf gas per day from perforations at 1,925-2,055 feet after heavy fracture treatment. This southeastern Sherman County well was the first official producer from upper Permian in the Texas Panhandle, and was given new field designation of Cator (Tubb) field.

But, when an Amarillo drilling contractor, H. F. Sears, recalled shows from a comparable horizon farther south in the Panhandle field, and promptly confirmed them with a Hutchinson County discovery gaged for three MMcf gas per day at 1,545-1,612 feet, the pay began to look more prospective. Two Moore County tests by Natural Gas Pipeline Corporation of America soon followed. Production had hardly been indicated in the first of the pair when the Red Cave play broke wide open.

Cause of the sudden surge of interest was the news of Colorado Interstate Gas Company's success with the Red Cave. For four years that firm had been quietly engaged in a





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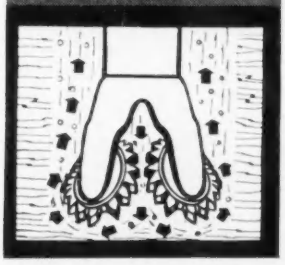

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Red Cave—Cinderella of Texas-Oklahoma Panhandles

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program involving the drilling of new wells, reworking of dry holes, and logging of old producing wells. The 14 wells which resulted from this program furnished an impressive amount of data at the hearing for consideration of field rules, requested by Colorado Interstate and held before the Texas Railroad Commission in March 1960.

Testimony presented at the hearing was the first definite indication of the size of the Red Cave reservoir. Colorado Interstate believed the Red Cave producing area to cover more than 165,000 acres, this estimate based only on the work done in the immediate area of its own holdings. A company spokesman pointed out, "We are involved with an area with much more than 100,000 acres; it's not small and it's going to take considerable evaluation to cover this thing."

Other companies were quick to join in the evaluation. Last June the pay was extended nearly four miles southwest of nearest Panhandle and Red Cave production by the Lee T. Bivins Pederosa 1, later gaged for 4.6 MMcf gas per day from perforations at 2,610-2,700 feet. This Potter County discovery was the first proof that production was not confined to Panhandle field, and it sparked a number of stratigraphic tests and wildcats both south and west of the old field.

First oil production was found in September, when the Sinclair Oil and Gas Company completed its Masterson Estate 1 discovery in Potter County, pumping 44 barrels of 29.8 gravity oil per day from selective perforations at 2,096-2,162 feet. This pay had been indicated previously by the Colorado Interstate Masterson 1-R in the same section, the latter well flowing 60 barrels oil per hour and 2 MMcf gas per day from perforations at 2,095-2,175 feet, but completing on calculated flow of 7.8 MMcf gas per day from additional pay at 1,936-2,029 feet.

World's largest gas field. That a reservoir of such proportions could be passed by in the face of daily, continuous drilling spanning almost four

Today's practice of fracturing and acidizing in combination with production—both initially and later—requires a new type of packer. It must dependably hold pressures from below and at the same time perform as an efficient production packer. It must be simply run and easily retrieved by the operator.

Afterthought Hold-Downs Not the Answer

Conventional long-stroke packers with a hold-down added to the mandrel as an extra cannot fully meet this need—they were never really designed for this kind of use.

The added hold-down created problems, and often did not hold dependably. Operators found that hold-down buttons would dull on the way in. The packer often proved difficult to release as there was no simple way to equalize pressure across the hold-down, and sand or frac materials tended to keep the buttons from retracting.

A New Concept Was Needed

In designing the Model "R" Packer to meet the operator's needs, Baker came up with a whole new concept. As explained below, button dulling has been minimized because the ample bypass area is completely isolated from pressure surges in the tubing. Pressure differentials across the hold-down and the packer can be instantly equalized by simply picking up on the tubing. The mandrel can be used as a jar at any time, as it is not held inoperative by the hold-down.

To the many advantages brought about by a new design approach, Baker added high-quality, performance-proved components never before found on long-stroke packers.

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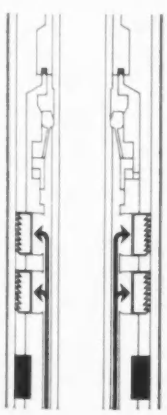
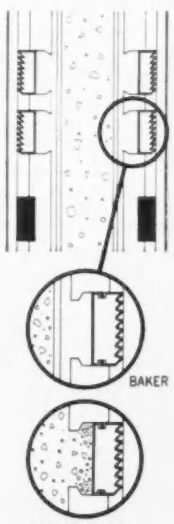
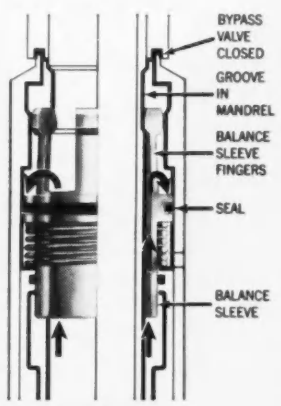


HOLD-DOWN IS ACTUATED BY PRESSURES FROM BELOW PACKER. The hold-down buttons are isolated from pressure surges in the tubing. Surface bleed-off is never required, as the bypass valve can be opened at anytime. Pressure differentials can be instantly equalized, even if the tubing is plugged.

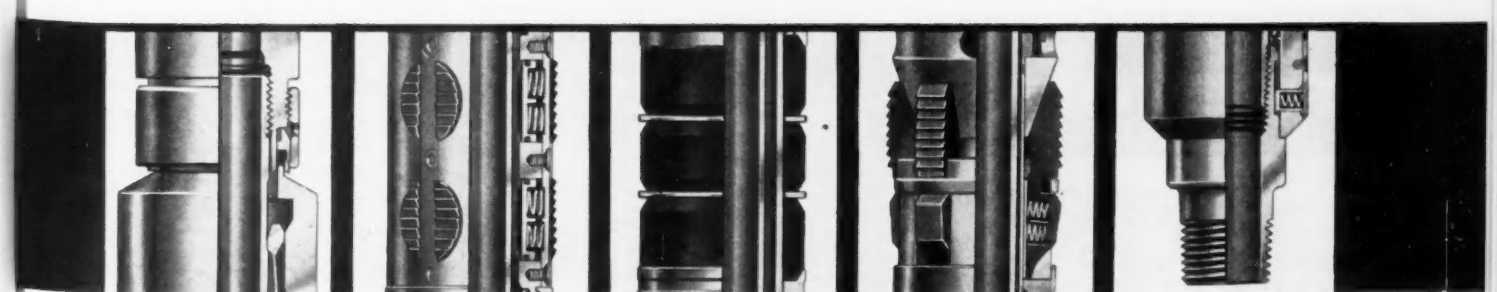
BUTTONS ARE ISOLATED FROM CONTAMINATED FLUIDS. Sand and other solids cannot build up in back of the buttons and thus interfere with button retraction.





UNIQUE DIFFERENTIAL LOCK HOLDS BYPASS VALVE CLOSED. Shown at left, in relation to the packer body, is the Balance Sleeve which forms an important part of the Differential Lock. Note how pressure differentials from below the packer act on this sleeve to force it down so that the fingers of the sleeve wedge into the groove in the mandrel. The very pressure that acts to pump the valve open thus acts to keep it closed—eliminating the need for high tubing set-down weights.

UPWARD MOVEMENT OF TUBING RELEASES LOCK. No rotation or pressure equalization is required.



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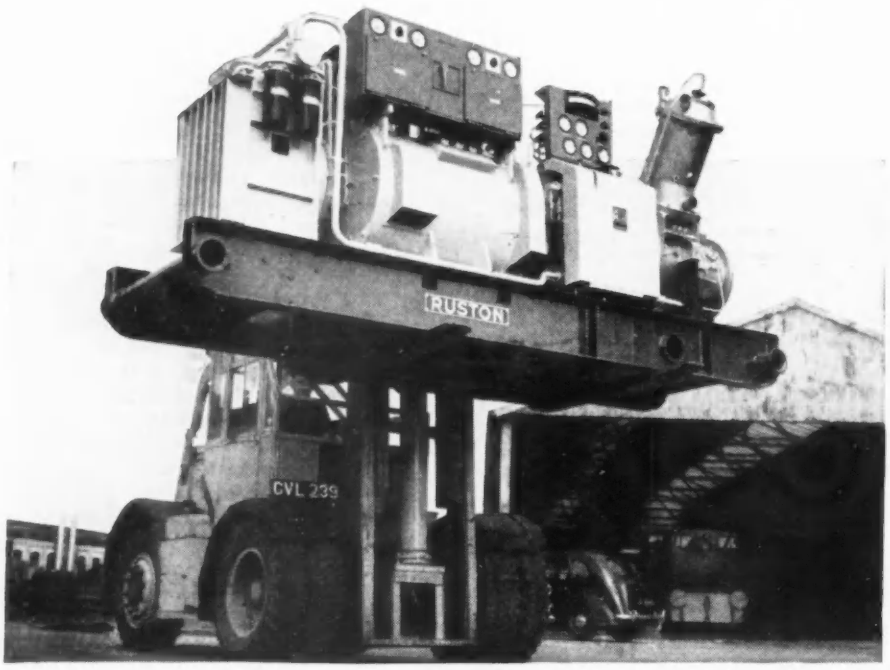

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Red Cave—Cinderella of Texas-Oklahoma Panhandles

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decades seems almost unbelievable. Yet such was the case with the Red Cave, and though a variety of explanations have been offered, the simplest, and probably the chief explanation, is simply the massive size and productivity of the Panhandle field.

The world's largest gas field, 125 miles long by 25 miles wide, the Panhandle field covers all or parts of nine counties in the northern part of Texas. It has produced more than 25 trillion cubic feet of gas from reserves estimated at nearly 40 trillion. Not widely known is that the field's oil-producing sector is almost as significant; second only to East Texas in the United States, its cumulative production is expected to pass the one-billion barrel mark in 1961.

Since discovery in 1918, some 15,000 oil wells and 5,000 gas wells have been drilled in the field, which covers a surface area of nearly 2 million acres.

Red Cave characteristics. Taking its name from its drillability during the heyday of cable-tool drilling, the Red Cave is a very fine-grained quartz sandstone, interbedded with shale and with some thin streaks of anhydrite and salt.

The sand, believed to be of blanket-type deposition over a large part of the Panhandle, generally lies in the top 50 to 150 feet of the Red Cave formation, and is overlain by a cap of anhydrite and salt. Average porosity of the sand is 16.5 percent, average permeability 16.8 md, average oil saturation 7.6 percent, average water saturation 48 percent, and average net effective pay 36 feet.

Structural control is believed responsible for gas accumulation, the greatest accumulation of Red Cave gas found thus far overlying the broad crestal arch of the Amarillo uplift, and conforming remarkably well to dolomite and granite wash formations below. Separation of the Red Cave pays from the highest of these deeper pays consists of about 200 feet of nonproductive Red Cave and 100 feet of lime.

Red Cave gas has a somewhat higher Btu content than gas found in other field pays, while helium content is much lower. Because of more nearly

ging and sticking.

teeth aids retraction.

metallic back-up rings.

Baker service tools.

stroke of the mandrel.

Red Cave—Cinderella of Texas-Oklahoma Panhandles

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virgin conditions, Red Cave reservoir pressures range from 100 to 200 pounds higher than those of deeper pays.

The formation appears to be a mud when drilled with cable tools, and rotary drilling washes out caverns which take large volumes of cement from casing set at deeper pay levels. Although within cable-tool economics, most Red Cave drilling has been done with rotary—air, gas and mud employed as circulating mediums.

Well costs. Completion techniques are generally uniform throughout the Red Cave area, operators setting casing through the pay, perforating selectively, and fracturing with relatively large volumes of sand and fluid. The fact that fracturing is essential in completions from Red Cave may in large part account for its non-development at an earlier date, for it appears that good commercial production will be obtained in many areas only through use of this process.

Cost to drill and complete a Red Cave producer runs approximately $20,000. Gas sale price in this West Panhandle area is 14 cents per Mcf, which after taxes, royalty and overrides, brings a net of 10 cents per Mcf. Operating costs run about $50 per month.

For an operator in the 52 percent tax bracket, net well cost would run about $13,750, requiring 137 MMcf gas at 10 cents per Mcf for payout. With reserves in good Red Cave areas ranging from 3.1 to 4.7 MMcf per acre, payout would require about 45 acres at the lower figure and about 30 acres at the higher, while a 4-1 payout would require 178 acres at the lower figure and 117 acres at the higher.

Red Cave future. Although at present confined mainly to acreage held by production, and classed as a "closed play" by some individuals, the Red Cave nevertheless can be considered a major exploratory campaign which already has opened up new areas of production, and promises even more for the future.

West of the Panhandle-Hugoton field, Red Cave production has been

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Red Cave—Cinderella of Texas-Oklahoma Panhandles

Starts on Page 104

found along the Cimarron Arch in Cimarron County, enhancing prospects for the Kerrick and Stratford areas to the south in the Texas Panhandle. Southwest of the Panhandle field, in the Palo Duro Basin of Oldham County, Shell Oil is testing for Red Cave production at the first of three Permian wildcats in an area where a 1959 failure made gas flow of 764,000 cubic feet per day. Commercial production was discouraged by presence of sulfur water.

In Potter County, Lee Bivins has completed two Red Cave gas wells to open first Red Cave production south of proven field limits. Even farther south are two more areas of significance—one the site of an early cable-tool failure which flowed up to 5 MMcf gas per day along with water from Red Cave and Wolfcamp, and the other an unusual geological feature which was the original source of helium-rich gas for the Panhandle's first helium processing plant. This, the Bush Dome, whose Wolfcamp gas now is depleted and which is to be used for crude helium storage, is reported to have Red Cave sand in all its original wells. Old records reveal that good Red Cave shows were recorded in the drilling of a number of these wells.

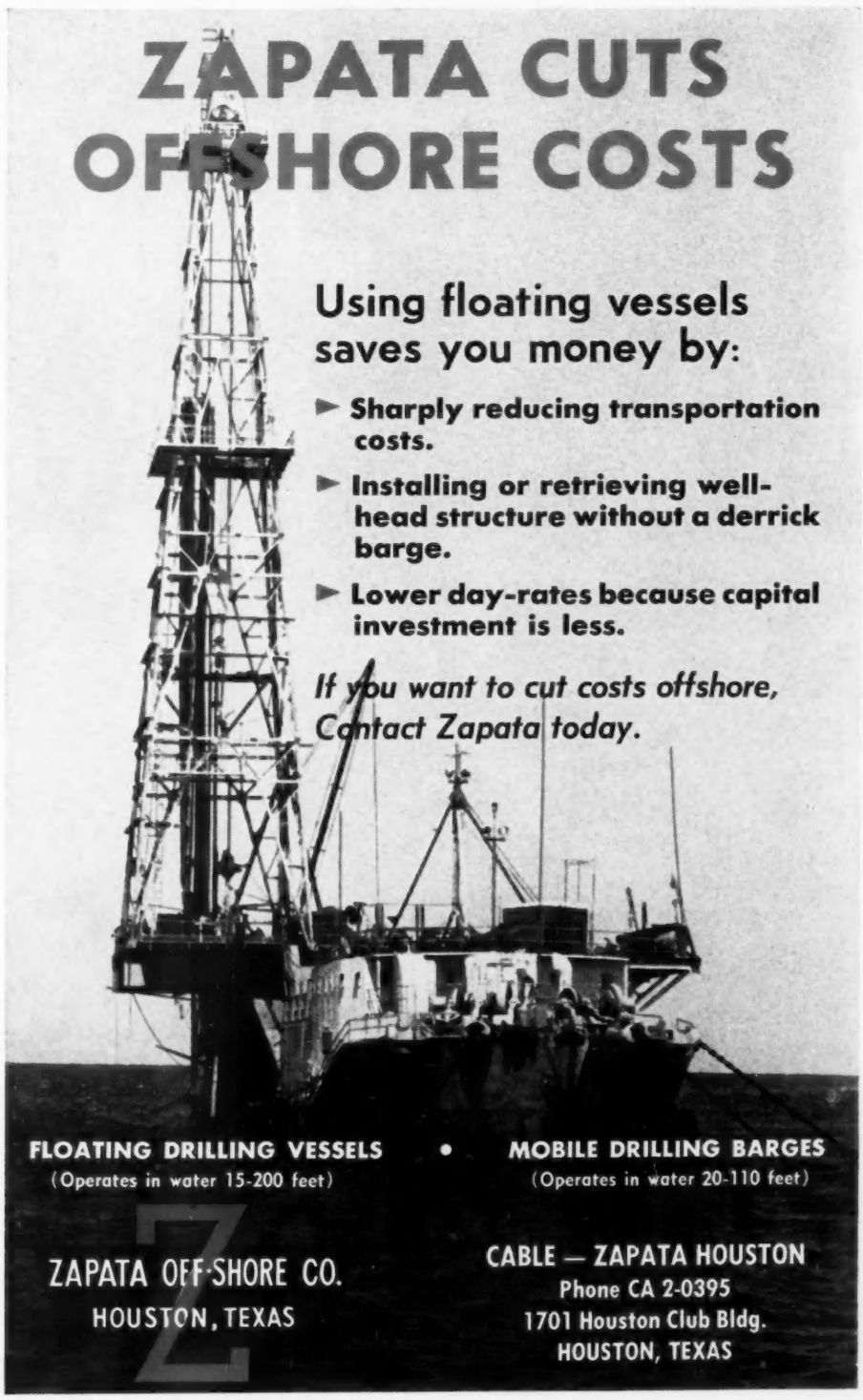
Of interest, also, is the discovery completed last year by Texas Gulf Producing Company six miles south of the Panhandle field in Carson County. The Bobbitt 1 was gaged for 9.5 MMcf gas per day from perforations at 3,247-3,400 feet in Wolfcamp dolomite, gas reported to be of low Btu-high helium content. In a province where 12 privately-owned helium plants will be built under terms of the new Helium Act, production of this type can be particularly rewarding.

At the present stage of development the Red Cave can be classed as only one of several pay targets for exploratory work south and west of the old field. A region of large ranches and equally large acreage blocks, this area is facing expiration within the next two years.

Faster and more exhaustive evaluation will be required, and from this evaluation perhaps will come not only the key to Red Cave production, but to the Palo Duro Basin enigma as well. **—The End**

About the Author

Curtis Stevens entered the oil industry in 1947, spending five years in geological departments of the Shamrock Oil & Gas Corp. and Texaco Inc. In 1952, he joined the staff of Rinehart Oil News Co., working in Midland and Dallas editorial offices. After a year with Management Service Corp., doing gas availability studies at Amarillo, he organized the National Petroleum Bibliography in 1956, a firm specializing in information research. He is holder of a B.A. degree in English from West Texas State College.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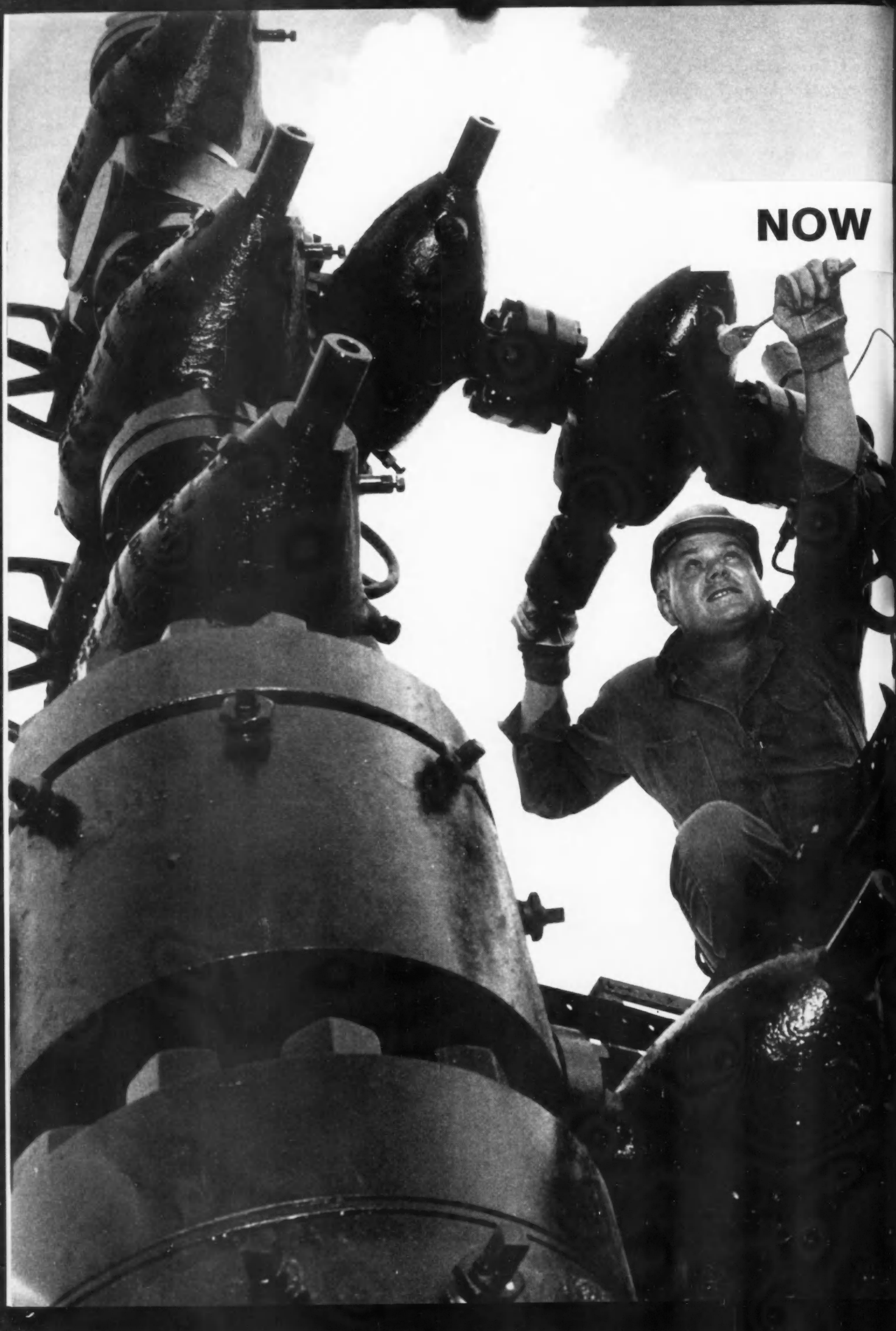
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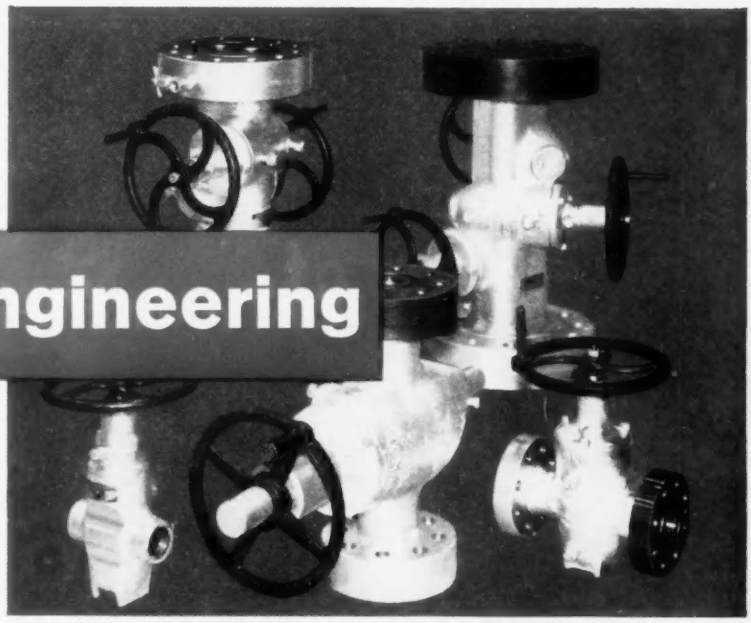

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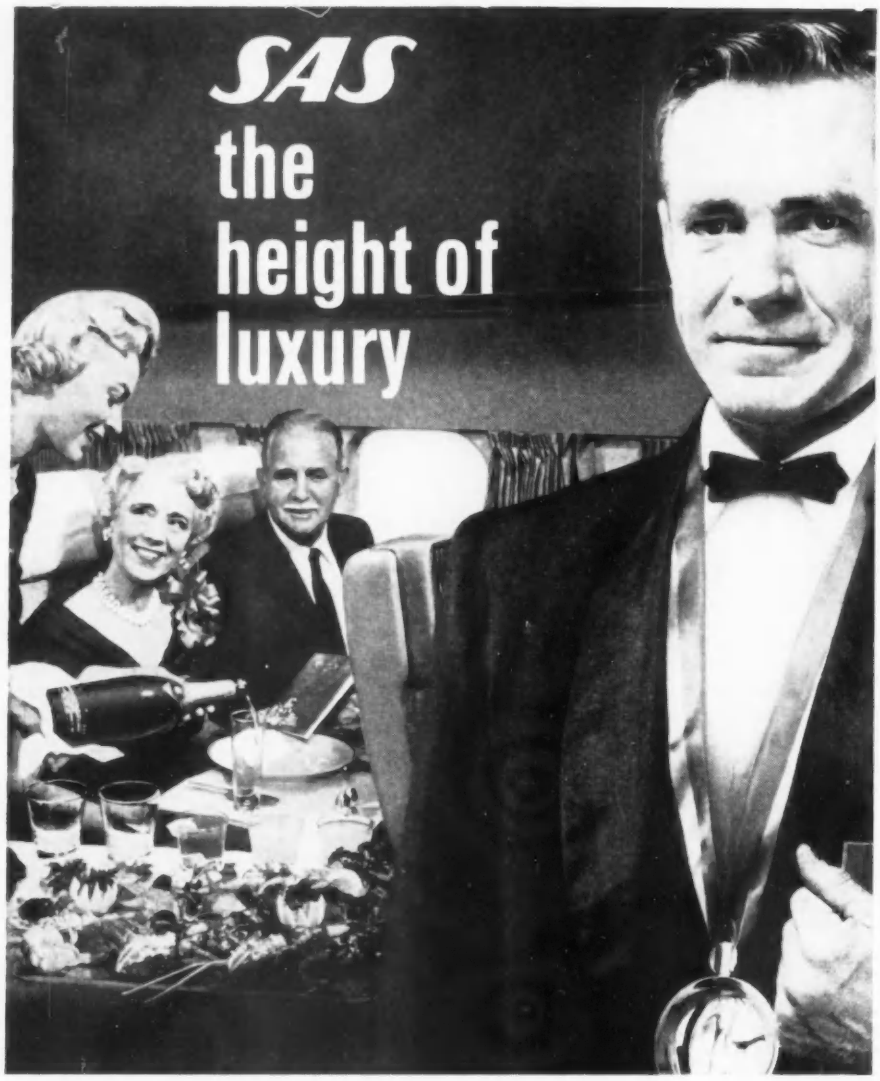

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Water channels through the filter and only a small portion of the original filter area is effective when this condition exists.

The pipe is bent into circular shape, perforated and placed in the filter between the fine rock and coarse gravel. A cutting torch is used to cut holes in the sides of the pipe at 10 and 12-inch intervals. Cutting the holes on alternate sides of the pipe keeps water distribution even. Holes close to the water source must be smaller and further apart than those near the end of the pipe, or the outer section will be starved for a water supply.

The assembly is then connected to a high-pressure water source (in this case the injection pump bypass).

During the backwashing operation, the pumper simply turns in backwash water and opens the valve on the high-pressure line. Water under pressure stirs the sand and does a thorough job of breaking up small lumps and preventing cementing.

Where a high-pressure source is available, cost of the installation includes only 20 feet of 1-inch pipe, a high-pressure valve and union, and miscellaneous connections.

Although the installation has not eliminated the cementing problem entirely, it has increased the life of filter media from 7 to 13 months.

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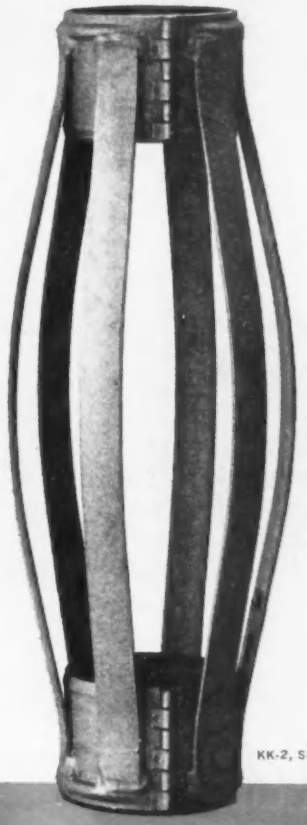

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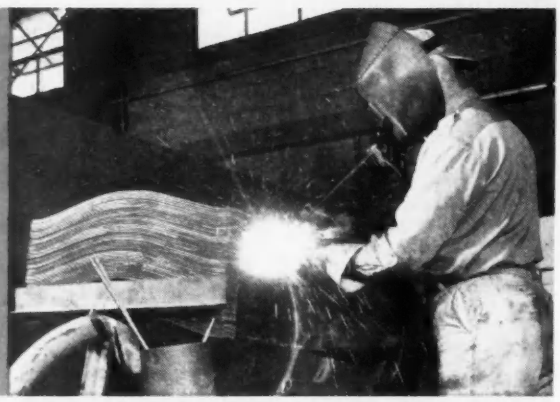

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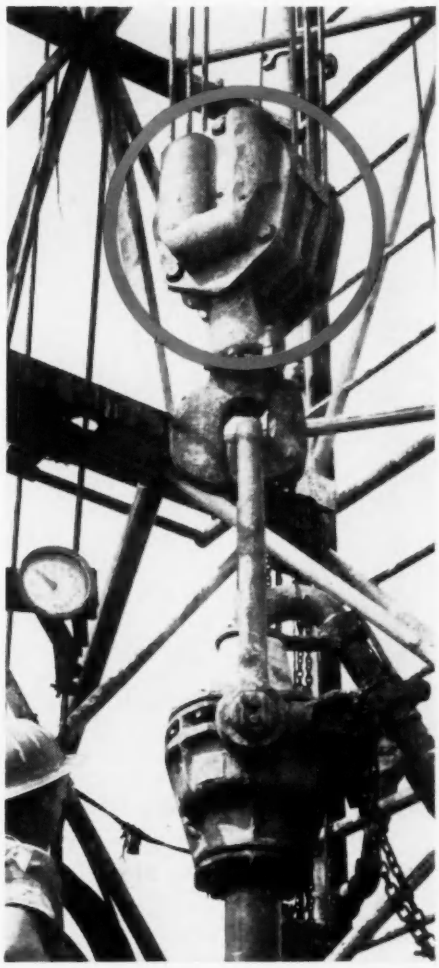

Lead-Filled "U" Tubes Speed Fall of Traveling Block

Cut a 4-foot length of 5-inch pipe in half longitudinally, weld it into two "U" shaped patterns on either side of the traveling block guard, fill the pipe sections with molten lead and speed the fall of the traveling block when it is empty.

This solution to a problem common to light drilling rigs was worked out by a contractor operating in central Texas. He first removed the guards from the block, mitre-welded the 5-inch pipe to the guards as shown. He was very careful to make both sides uniform so an equal amount of lead would be added to each side. Next, he filled the two sections with molten lead and replaced the guards.

The total gain in weight was something over 400 pounds. This was sufficient to speed the fall of the block under no load even though it was reeved with six 1-inch lines.

Aside from adding weight, this modification does not affect the capacity of the block and the added speed saves time and money in the early part of the hole.

INTERIOR SECRETARY UDALL
Taking a personally active part

Bigger role for Interior Dept.?

How Secretary Udall views oil and gas

- More potent Oil Imports Administration
- Reorganize Office of Oil and Gas
- Early action on oil, gas and coal matters
- Close look at Canadian imports
- Check offshore installation safety factors

These are just a few of the objectives announced by Secretary Udall in this exclusive WORLD OIL interview.

LIKE PRESIDENT KENNEDY in the White House, Secretary Stewart L. Udall has brought a new brand of executive vigor to the Interior Department.

Since his unanimous confirmation by the Senate January 21, he has become well briefed on every point of the Interior compass and is taking a personally active part in the formula-

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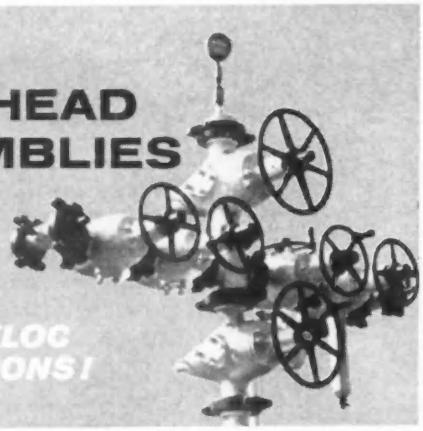

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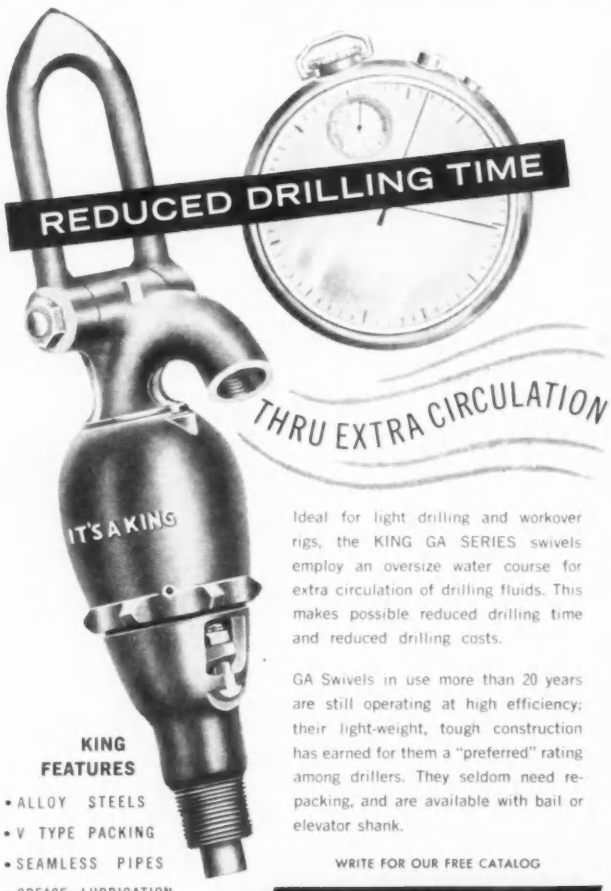

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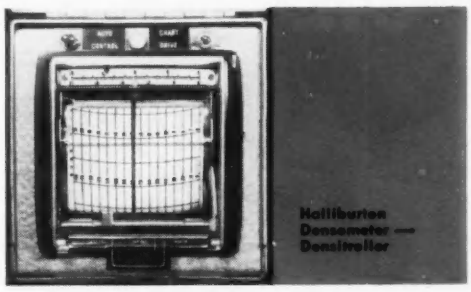
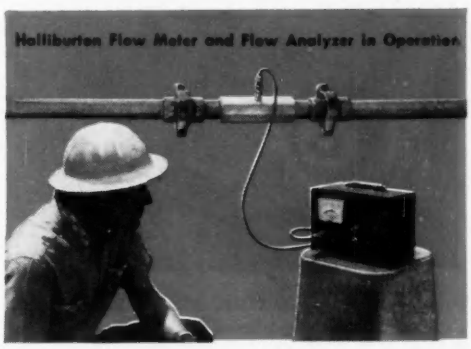
2 automatically controls slurry density



The new Halliburton DENSITROLLER is the controlling instrument which maintains the cement slurry weight desired. This weight is pre-set on the Densitroller by the operator. The instrument then controls the system to maintain this pre-selected weight automatically, regardless of changes in flow rate and/or pressure. With the Densometer and Densitroller both in use, the pre-set density can be changed by the operator at any desired point during the job by resetting the density selector. The slurry weight is continuously recorded on a strip chart.

3 measures slurry flow rate



The Halliburton Turbine FLOW METER and FLOW ANALYZER makes possible the determination of the cementing plug's position at any time during the cementing job. Also, in plug back or squeeze operations, the cement position can be more quickly and easily calculated at any time. These calculations are based on the continuous gpm flow rate and cumulative total flow readings displayed by the Flow Analyzer. This data is obtained by the Turbine Flow Meter which is installed directly in the slurry flow line, and continuously transmits the data to the Flow Analyzer.

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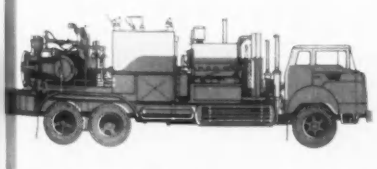

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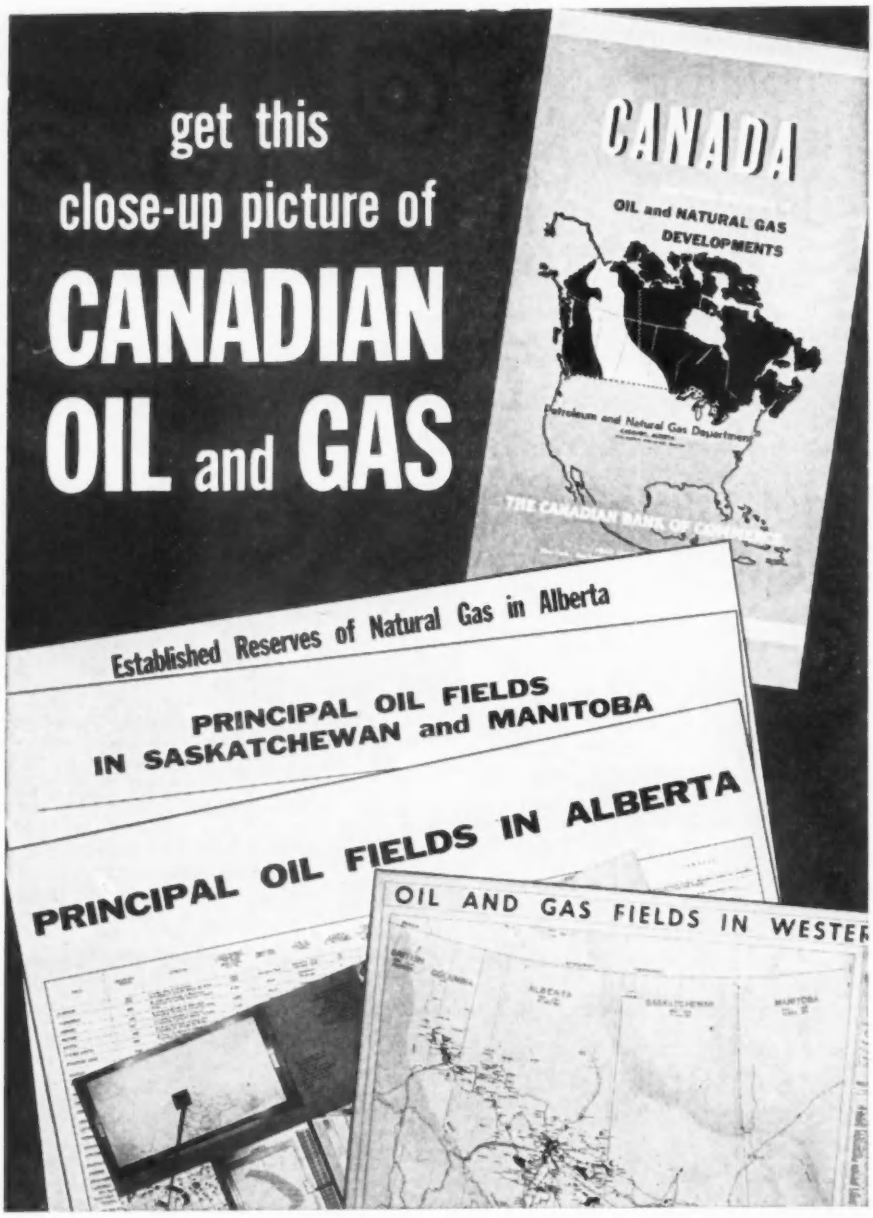

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"There will be some personnel changes . . . . we are striving for a balanced, productive program"—Udall

Starts on Page 126

tion of plans and policies on other levels than the final decision-making plateau.

To ask the Interior secretary what action he plans to take on many key issues is to learn that he already has begun to act upon them. For instance:

On potential changes in Interior's oil and gas regulatory agencies and their functions—"I hope to strengthen both the Office of Oil and Gas and the Oil Import Administration. I can assure you there will be some personnel changes. Our over-all goals and

JOHN KELLY
Assistant has oil background

objectives are to stabilize and strengthen the (energy producing) industries and to assure adequate supplies where they are needed at prices fair to the consumer and profitable to the producer. We are striving for a balanced and productive program."

Actually, Secretary Udall had already acted to strengthen the regulatory machinery for petroleum and gas by appointing John Kelly, of New Mexico, as assistant secretary for min-

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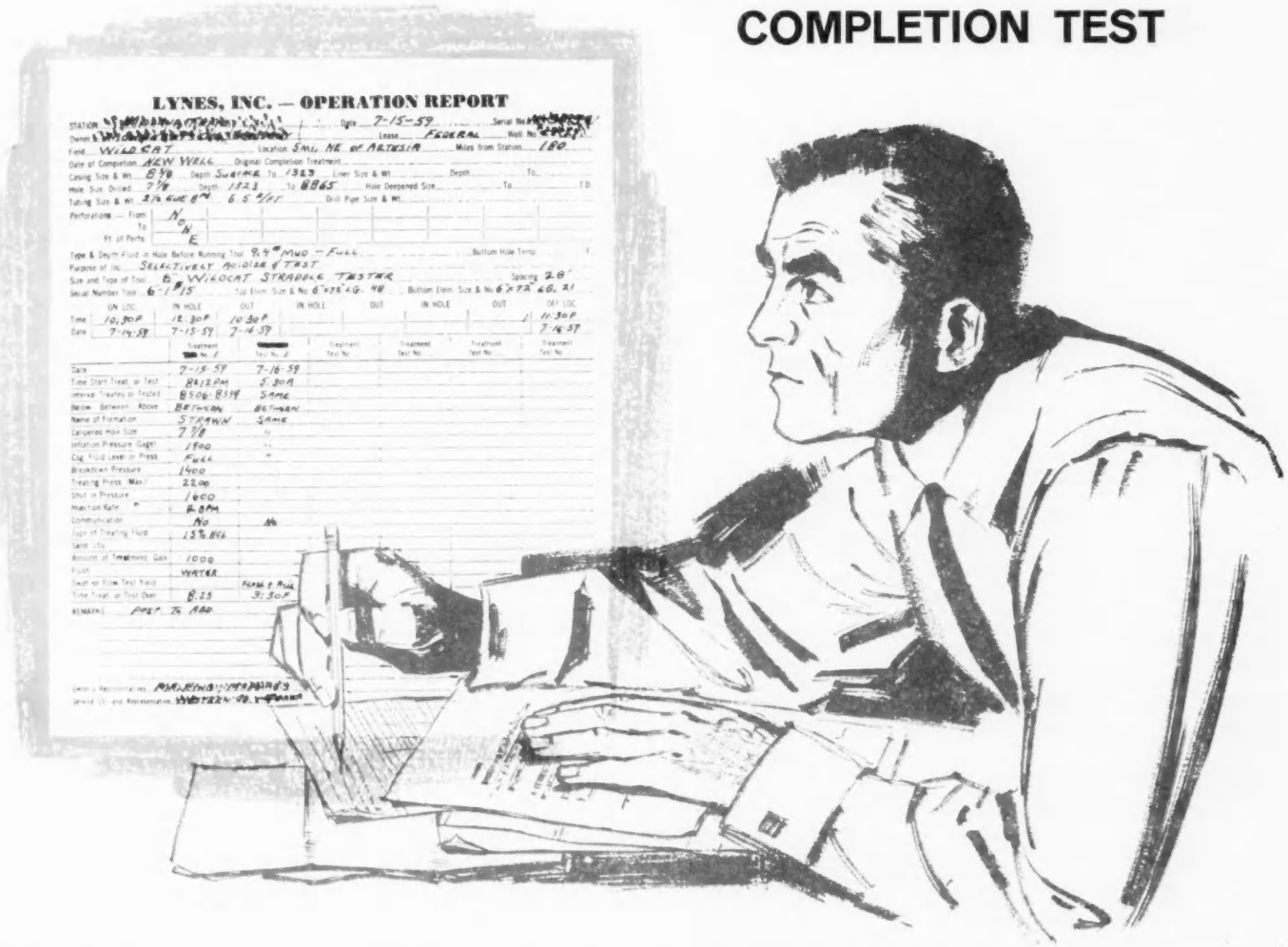

LYNES Wildcat Open-Hole Test Service takes the gamble out of completion of questionable 8800-ft. New Mexico wildcat. Drill stem tests on a wildcat in the Artesia, New Mexico, area had been inconclusive so the operator was faced with the choice of setting casing, perforating, treating the formation and recovering the casing if the hole was a duster or of abandoning the well without additional testing at the risk of passing by a producer OR HE HAD THE CHOICE OF RUNNING A LYNES OPEN HOLE INFLATABLE WILDCAT TEST STRADDLE PACKER THAT WOULD ALLOW HIM TO MAKE POSITIVE WELL TESTS AT A VERY LOW COST.

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The swab test through a LYNES Tool is more positive than a D.S.T., but the potential of the LYNES Test does not stop there. Stimulation treatment is a normal progression of this test—then further Swab Testing.

Many operators do not D.S.T. where results are expected to be questionable. They drill to T.D., then come back up hole testing all shows.

Single element tools can be opened above or below and straddle tools can be opened above, below or in between. LYNES Inflatable Tools can be reset anywhere in hole without tailpipe or formation anchor.

LYNES Inflatable Packers have endless variety of uses in testing, treating and production operations in the field. The inflatable sealing element will expand up to twice its run-in size to effectively seal in open hole or casing and will hold high differential pressures from above or below.

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"The Office of Oil and Gas will be upgraded . . . a top level executive is going to head it"—Udall

Starts on Page 126

eral resources. The new assistant secretary has headed his own oil producing firm for 15 years; is both a graduate mining engineer and petroleum engineer, and is a former executive director of New Mexico's Oil Conservation Commission, which he helped organize.

"The Office of Oil and Gas is to be upgraded, and a very top level, qualified executive is going to head it—whenever we find him," said Secretary Udall, adding that the "dragnet is out."

To help him find top level men to guide oil and gas regulation, Udall has brought in Major J. R. Parten, of Texas, as a special consultant. The duties of Major Parten, long an ambassador from the oil industry to top level state and federal government include "helping with personnel and strengthening oil and gas organization within the department."

While neither Udall, Kelley or Parten are yet waving new organization charts, the framework to make Interior the real and active nerve center of governmental domestic and international concern with petroleum is definitely under construction. By retirement, Udall has lost the services of Capt. Matthew V. Carson, USN, as director of the Office of Oil and Gas, but the search is on for his successor.

Secretary Udall says the functions of Interior's agencies concerned with oil and gas—and coal—will be upgraded on a par with such agencies as the Geological Survey, which is headed by top scientists. The energy producing industries have been told to help find the qualified personnel.

Interior's interest in petroleum is global: "We expect to strengthen and stabilize the oil and gas industries in ways that will enable them to contribute substantially to the rate of national economic growth, and to achieve, by day-to-day efforts, our other appropriate long-term national goals. We also expect to make those proper adjustments necessary to the world situation which is of increasing importance," the secretary said.

Earlier, to the National Petroleum Council, he had stressed the need for national policies on oil and gas and described those industries as "the core of America's economic and military strength . . . pivotal to the welfare and cohesion of the free world."

The accepted functions of the Office of Oil and Gas are:

- Staff advice and assistance (to the assistant secretary for mineral resources) on programs assigned to the department by the White House and Congress.

- Leadership in coordinating oil and gas policies in the federal government to assure adequate facilities and supply in time of peace and war.

- Serve as principal channel of communication between the federal government and the Interstate Oil Company Commission, state regula-

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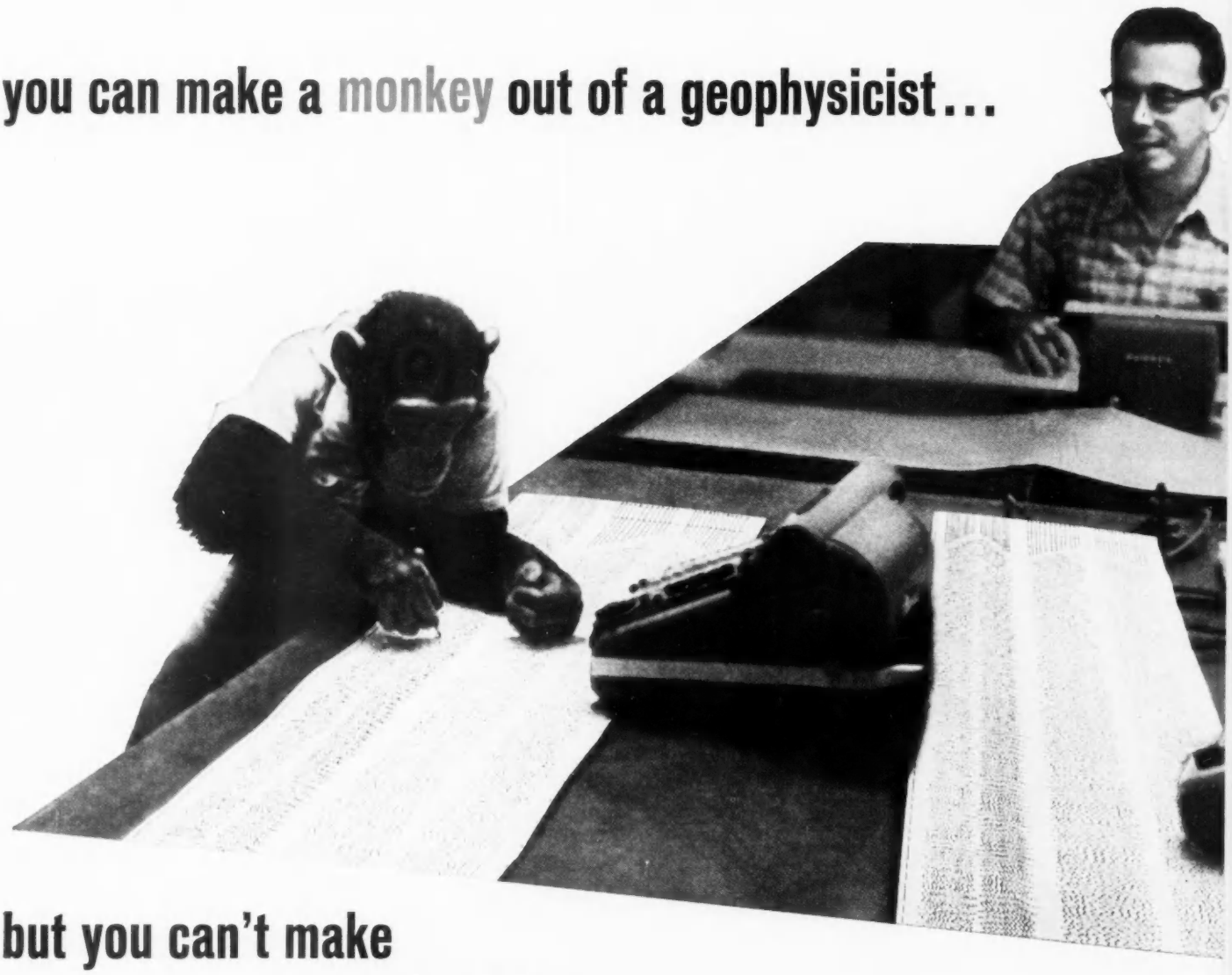

but you can't make a geophysicist out of a monkey!

It doesn't take a monkey to tell you that you get only what you pay for — in the geophysics field as in others.

One of our camp followers, Fidel by name, puts on a pretty good act among the record sections, slide rules, and delicate electronic equipment and looks sort of professional behind a desk.

Fidel might be taught to perform some fundamental chores with only an occasional banana break, but if any oilfields were discovered through his antics, they would be strictly accidental — and you can't afford to gamble on accidents.

The moral is this: Leave your geophysics to the proved professionals.

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ROGERS' CREWS GO EVERYWHERE

" . . it (Canadian imports plan) could conceivably work against the interests of the domestic oil producing industry"—Udall

Starts on Page 126

tory bodies and the oil and gas industries. Carry out the provisions and functions authorized by the Defense Production Act of 1950.

• Appoint and train a National Defense Executive Reserve for Petroleum and Gas.

It has become apparent to Washington that Secretary Udall intends to emphasize the "leadership" function of his department.

The Oil Import Administration was established by Presidential Proclamation under the Secretary of the Interior. It is staffed and serviced in part by the Office of Oil and Gas, and depends now for its basic statistics on the Bureau of Mines. The Import Appeals Board is distinct from the OIA.

On proposed increase in Canadian imports: "The plans of the Canadian government to increase the marketing of hydrocarbon exports to the United States, as the Department of the Interior understands these plans, would result in a gradual increase in Canadian imports of crude oil, condensates, and natural gas liquids over current levels during the next three years.

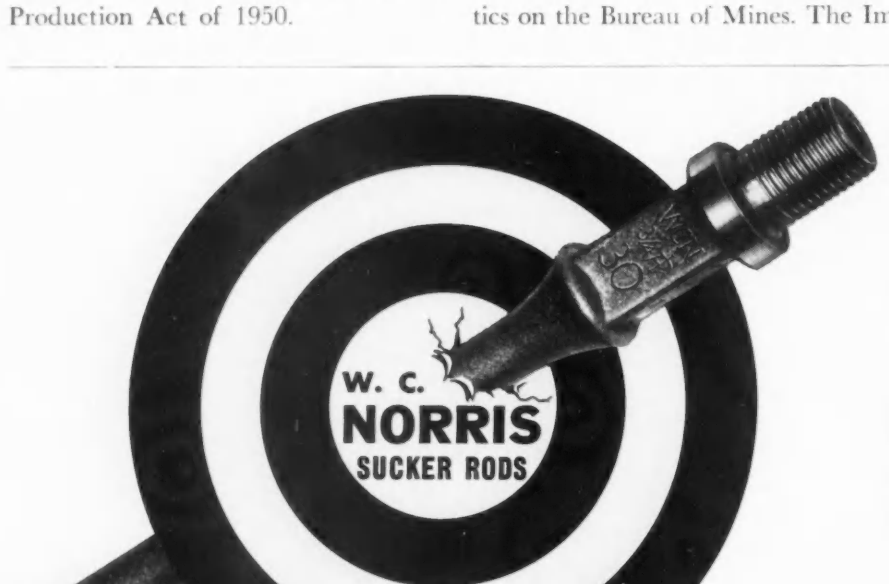
"From our talks with the Canadian representatives, the proposed planned increases would move predominately into the Pacific Northwest where they will largely displace other imports rather than domestic production. A lesser quantity would move into the upper Midwestern area which is currently served, to a large degree, by Canadian imports. When these quantities can be more accurately determined, we feel assured that this information will be made available to the United States Government and to the domestic producers of our nation.

"Within the framework of the announced Canadian plan the contemplated increase in imports of hydrocarbons—properly and orderly timed—should not materially affect oil production within the United States.

"Speaking candidly, however, I feel compelled to say that, if the plan is not implemented by gradual steps, it could conceivably work against the interests of the domestic oil producing industry in the United States. Our domestic producers understand the policy considerations which underlie the current exemption of Canadian imports under the mandatory oil import program. However, if the Canadian plan has a marked and abrupt adverse effect on our petroleum industry, such action would undoubtedly furnish the basis for a review of the pattern of U.S. oil import controls as they pertain to Canadian crude oil, condensates, and natural gas liquids."

On residual imports and the mandatory oil imports program: "The new residual fuel oil import regulations (March 9) is part of a program to be administered to keep in balance our domestic and foreign fuel supply. It is of necessity a compromise which we hope will tend to stabilize prices and satisfy demand."

Secretary Udall added that while the new residual import regulation,



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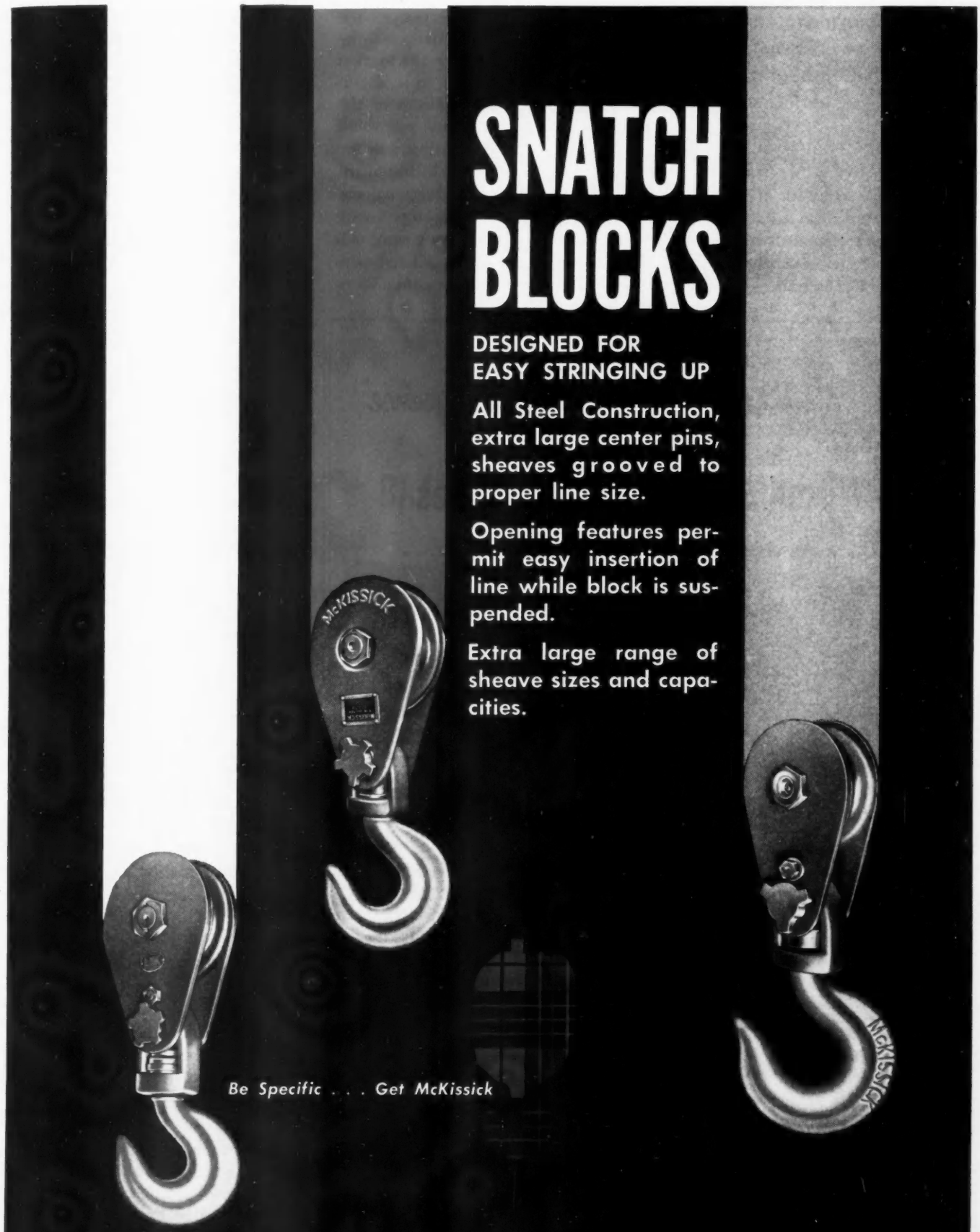

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"The Department . . . is continuing an investigation on increases of fuel oil prices . . ."—Udall

Starts on Page 126

which established on an annual basis a maximum level of 461,427 barrels per day, was not basically an instrument for fuel price control, it was expected to help stabilize prices and maintain them at levels fair to the consumer. It was also designed, he indicated, to help stabilize the market between competing fuels.

The long term implications of the new regulation on residual oil would indicate the Administration has no thoughts at present for lifting mandatory controls. For instance, allocations for "historical importers" were reduced and, under the program, will decline "each year" by a fixed percentage.

Whether there will be sharp revisions of the regulations controlling the importation of crude oil, will depend on the results of investigations now under way—and probably public hearings, the Interior Secretary indicated.

On the investigation of fuel prices: "The Department of the Interior, along with the Justice Department and the Federal Trade Commission, is continuing an investigation asked by President Kennedy on increases of fuel oil (distillate) prices in certain areas," Secretary Udall said.

He declined to map the area of the investigation or to say when it would be concluded. He noted, however, that heating oil prices had receded in certain areas since the investigation began. "The more they recede the better," he remarked.

The Anti-Trust division of the Justice Department said its investigation embraced both No. 2 heating oil and residual. The Justice spokesman, too, was not inclined to reveal the extent of the investigations or if they would be extended beyond the East Coast area.

Secretary Udall said the Interior Department would not, as a matter of policy, undertake oil price investigations as a general rule. He added that part of the function of the OIA was to keep an eye on price fluctuations.

The "Texas tower" disaster and offshore drilling: While the Interior Department has launched no formal program for tightening safety regulations for offshore drilling platforms, the Oil and Gas Conservation section of the Geological Survey said its field men would take a "closer look" at such installations in light of the collapse of the "Texas Tower" off the Atlantic Coast earlier this year.

Rep. Herbert Bonner's Maritime and Fisheries Committee of the House plans to conduct a hearing or investigation into the safety and seaworthiness of offshore installations within the next few months, a staff member said. The U.S. Coast Guard is made responsible under the Outer Continental Shelf Lands Act for the safety of such structures. Coast Guard spokesmen said that at present only escape and survival apparatus on oil drilling platforms is inspected—not structural factors.

On a national fuels policy: What-

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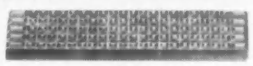

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ever Congress finally decides to do about a national fuels policy study or a national fuels policy, Udall is not in a mood to wait on it. Earlier he had said on the subject:

"You, of course, could have a congressional study, you can have executive studies, or you could have a joint one. Actually, the broader the base you get on it the better, it would seem to me, as a matter of policy." Since then he has apparently had second thoughts.

"Here at Interior we can't sit still and wait for a drawn out study before we act on matters concerning the major fuels," he told WORLD OIL. "We inherited an ad hoc situation January 20 and we have had to act from day to day on problems and situations as they arise and demand attention. Actually, we are conducting a continuing fuels study and will continue to do so.

"The long public hearing on residual oil imports was in itself a study. We got the views of all factions of the indutsry, weighed the many considerations and then took action we thought would serve the country's interest best.

"The lack of a formal national fuels policy may be something of a handicap, but actions can't wait until one is finally formulated."

One broad policy relating to fuels which Interior along with the White House seems to have formulated is that, in the words of Secretary Udall, "The interest of the consumer is paramount!"

That the new secretary of the interior will give petroleum, gas and coal a dominant role during his administration is seen in his personal participation in matters affecting these energy producing industries. He has accepted an inviation to visit the coal areas of West Virginia; he conducted the residual import hearings and worked on the new regulation issued March 9. He has designated himself co-chairman of the National Petroleum Council and has promised to attend its meetings, and he is in daily conference with Assistant Secretary Kelly and other top aides concerned with fuels.

Secretary Udall's continuing interest in matters pertaining to the industry was recently summed up by Lawrence J. O'Connor, Jr., OIA administrator, who said:

"Secretary Udall has taken—and, I am sure, will continue to take—an increasing role in petroleum affairs, one far greater than any of his more immediate predecessors. Decisions affecting oil will be made with greater public participation, of greater public awareness of their impact on our society, and in a larger frame of reference of the greater public interest. Decisions will be made forthrightly, with no illusion that compromise can substitute for determination—with no illusion that hard decisions which meet full responsibility will satisfy all particular interests."

" . . . we can't sit still and wait for a drawn out study before we act . . . on major fuels"—Udall

—The End

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With a similar rack on both sides of the float, drill pipe and collars are easily handled. When the float arrives on the job, the drill pipe is rolled off onto the racks as shown here, and the collars are left on the float to be used first in the string.

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A sizable part of World Oil's editorial program is ignited by readers themselves through letters to the editor. Not only do we welcome and appreciate your reaction to World Oil editorial articles but also we earnestly invite you to tell us what subjects you would like to see us cover.

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Your industry at work

A monthly roundup of items of interest about people, companies and associations

V. M. Brown Appointed to National Petroleum Council

Vincent M. Brown of Washington, D. C., has been appointed assistant secretary-treasurer of the National Petroleum Council. Brown's appointment became effective March 1.

Brown has been identified with the work of the APC for 10 years. He has an extensive background of experience as secretary to many of the committees of the Council which have made special studies or surveys on all phases of domestic petroleum and gas industry operations. Brown has served as statistician, analyst and attorney on the Council staff. He is also a member of the Petroleum and Gas Unit of the National Defense Executive Reserve.

Academic Chair in Mineral Law Established at LSU Law School

The establishment of an academic chair in mineral law in the Louisiana State University Law School through a grant from the Superior Oil Company has been announced by University and company officials.

This is the first establishment in the Law School of a major University chair with industrial cooperation of this nature, according to Dean Paul M. Hebert.

The oil company's gift of $16,000 annually to support the chair for a four-year period was accepted by the LSU Board of Supervisors at its regular meeting held recently. Present plans call for an appointment to fill the chair by September if possible, the dean said.

Western Development Acquires Interests From Penn-Ohio Gas

Western Development Company of Delaware, independent oil and gas producer, has purchased a one-third working interest in 935 oil and gas leases from Penn-Ohio Gas Company for $621,000. The transaction was on a basis of 50 percent cash payable immediately and the balance on September 1.

Approximately 207,400 net acres (637,500 gross acres), located in Colorado, Montana, Utah, New Mexico and Wyoming are involved. Of the total leases, a majority, or 602 leases, covering 138,600 net acres (423,300 gross acres) are located in Wyoming. All the acreage, although non-producing at present, is located in highly active oil and gas areas where 10 to 15 wildcat wells are currently drilling. Western has entered into a lease management and operating agreement with Hiawatha Oil & Gas Co. and Benedum-Trees Oil Co. for the management of the property.

Tennessee's New Skyscraper. This is the architect's conception of the 33-story headquarters office building for Tennessee Gas Transmission Company and associated companies to be built in downtown Houston. Construction will start before mid-1961 with completion scheduled by early 1963.

United Australian Oil Limited Formed As Exploration Firm

The formation of a new Australian oil and gas exploration company, United Australian Oil Limited, has been announced jointly by Texas American Oil Corporation of Midland, Texas, Landa Oil Company and Nortex Oil and Gas Corporation of Dallas.

The three firms pooled their Australian oil and gas concessions into one organization in order to spread risks and cost and to provide more diversified and more widely distributed interests in Australia so that a strike anywhere would benefit the new company.

To be jointly owned and operated by the three firms, the new concern will have approximately 28 million acres of oil and gas concessions in the States of Queensland, Northern Territory and New South Wales. United Australian also owns 4,656,000 net acres of over-riding royalty under 67 million acres of Australian concessions. The royalty consists of 800,000 acres under Hunt Oil Company's concession in western Australia; 256,000 acres in the Murray River Basin, and 3.6 million acres in Queensland.

United Australian Oil's first test well will be drilled in Queensland and operations are to commence this spring. That project will be drilled on a 12 million-acre concession in Queensland and is

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proposed to 5,000 feet to test the Permian Section.

Dr. Karl A. Riggs, consulting geologist of Dallas, in a surface geological report, states the prospect has in excess of 1,000 feet of structural closure. The test will be 77 miles southwest of Rockhampton, a city of more than 40,000 population.

General Exploration Company Receives Burma Licenses

General Exploration Company of California has received oil exploration licenses covering 10,000 square miles in the Irrawaddy Basin from the Government of the Union of Burma.

Of considerable significance is the fact that these are the first licenses issued to a foreign oil company other than the Burma Oil Company, which is 51 percent owned by the Burmese Government, according to the announcement.

Other foreign holdings of General Exploration include a 50 percent with Santos Limited, in a 3,136,000-square exploration license in South Australia on which the first exploratory well was spudded February 1. The company also has 2,000 square miles of petroleum licenses on the Sudan Red Sea Coast.

Stiles Engineering Contracted By PETROREP in Paris

W. E. Stiles Engineering, Inc., Tulsa based petroleum consulting and property management firm, has signed a contract with PETROREP, and integrated oil company headquartered in Paris, France, to provide full time engineering and supervision of PETROREP'S drilling, completion and producing operations.

R. O. Courtright

Raymond O. Courtright, Jr., has been employed by Stiles ot handle the PETROREP assignment. Courtright succeeds Richard W. Coburn, vice president of Stiles, who has been handling the Paris assignment on a temporary basis for the past several months.

Principal oil production of the company is in the Paris Basin area, where it holds a large concession and has discovered the Coulommes field which produces from the Dogger Lime formation at a depth of 6,000 feet.

Oilmen's Golf Tournament At McAllen, Texas, May 26

The second International Oilmen's Golf Tournament has been scheduled to be held in McAllen, Texas, on May 26, 27 and 28, at the 18-hole McAllen Municipal Golf Course.

Oilmen who are interested to participate, should contact Joe Cannon, Sun Oil Company, P.O. Box, McAllen, Texas, for details. Entries are limited.

American and Mexican Interests Form International Corporation

Constructora Otila, S.A., a new international drilling corporation, has been formed between American and Mexican interests for drilling of oil and gas wells. Its first contract is to drill for Petroleos Mexicanos, S.A., in northeast Mexico in Reynosa.

The new enterprise is administered by officials of Continental Drilling Company of New Orleans and some of the leading Mexican drilling contractors and engineers. Offices have been set up in Reynosa and Mexico City.

Federico Stoffel, Mexico City, is president and general manager of Constructora Otila, S.A. Marshall Smith, Sr., of Continental Drilling Company, will be in charge of the Mexico City office. Joseph M. Rault, Jr., Continental Drilling Co., will be in charge of coordinating the activities of Constructora Otila and Continental Drilling. Marshall Smith, Jr., of Continental, will continue to be in charge of the firm's operations in South Louisiana.

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to waterflood operators who do not fracture wells

A few operators are still afraid to fracture waterflood injection and producing wells in spite of the fact that fracturing programs for waterflood projects are widely accepted. Here are some questions frequently brought up by these operators. The answers are based on records of thousands of treatments performed by Dowell.

QUESTION:

Will fracturing hasten breakthrough between injection and producing wells?

ANSWER:

Generally speaking, *no!* A poorly-designed fracture treatment of a producing well — performed too early in the life of a flood — can hasten breakthrough. In practice, however, this seldom happens.

Normally, breakthrough has been either unaffected or actually retarded by Dowell-engineered fracture treatments that were performed at the correct time.

QUESTION:

Will a premature breakthrough reduce ultimate economic recovery?

ANSWER:

If breakthrough does occur between an injection and a producing well, loss can usually be avoided by an appropriate change in the well pattern.

Dowell-engineered fracturing, however, has generally reduced, rather than increased, premature breakthrough.

QUESTION:

Will breakthrough to formation water reduce economic recovery?

ANSWER:

Loss can usually be avoided by changing the pattern of producing wells and injection wells. If formation water is likely to be a problem, however, Dowell engineers often design treatments to avoid breakthrough.

QUESTION:

Will fracturing affect water/oil ratios?

ANSWER:

Not in a consistent manner. Water/oil ratios may be increased, unchanged or reduced by fracturing. This is usually unimportant, however, since a waterflood that has been fractured should accommodate a higher water cut economically than one that is operated without fracturing. Dowell engineers design treatments on waterflood wells to avoid excessive water production.

QUESTION:

Will fracturing increase water handling costs?

ANSWER:

Fracturing programs have generally *reduced* water handling costs per barrel of oil produced. The daily costs of water handling may be increased, since so much more water is being handled, but oil production is usually increased so much that cost per barrel of oil is reduced.

Dowell engineers regularly design fracture treatments to minimize water pumping costs.

QUESTION:

Will fracturing costs reduce net profits?

ANSWER:

Fracturing costs have been negligible when compared with the savings realized. When successful fracturing programs are employed, fewer wells are required and well spacing can be wider. Since frac jobs are considerably less expensive than the drilling of new wells, the investment required for a given flood is decreased rather than increased by a successful, well-planned fracturing program.

When a successful fracturing program is initiated, daily production is increased while operating costs are affected little if at all; the result is lower operating costs per barrel of oil.

Dowell-engineered fracturing programs have been outstanding in helping waterflood operators increase net profits.

To summarize, waterflood operators have everything to gain by checking on the advantages of fracturing wells in a flood. For full information, call your nearest Dowell representative. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma.

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Men in the industry

R. E. Knoblock

J. C. Tapp

Harrison L. Townes, formerly division geologist, **Helmerich & Payne, Inc.,** has been designated exploration manager. Other appointments include: **Richard N. Knoblock,** who joined the company in January, named chief engineer in the Production Department, and **Jay C. Tapp** who was appointed assistant to the president.

H. L. Townes

John L. Gibson, head of the **Republic National Bank of Dallas** Time Credit Department, and **J. Lewell Lafferty,** in charge of the National Accounts Department, have been advanced from vice presidents to senior vice presidents.

James R. Puckett has been appointed producing superintendent of **Mobil Oil Company's** Casper, Wyo., exploration and producing district.

J. Harold Perrine has been appointed director of **Sun Oil Company's** Industrial Relations Department, succeeding the retired **William E. Zimmerman.** Perrine is succeeded as assistant director by **John H. Ashenfelter.**

John A. McCone has been elected a director of the **Standard Oil Company of California.** McCone was chairman of The Atomic Energy Commission in the Eisenhower Administration.

Gene Hart has been appointed Mid-Continent advertising manager for *World Oil* and *Pipe Line Industry* magazines. He will headquarter in **Gulf Publishing Company's** Tulsa office. Hart had been advertising manager for the company's *Petroleum Refiner* magazine since 1958. Previously, he had served as eastern advertising representative for the refining magazine in New York. Hart joined Gulf Publishing in 1950.

Gene Hart

Louis J. Brunel, an officer of **Bishop Oil Company** since 1927, retired as president of the firm. The board of directors elected geologist **Donald I. Lawless,** vice president of **Canadian Bishop Oil, Ltd.,** to succeed him. Brunel will continue as a director and serve the company in a counseling and advisory capacity.

George B. Parks, formerly vice president of production and drilling operations, **Kerr-McGee Oil Industries, Inc.,** has become vice president in charge of all oil and gas exploration. Assisting Parks in the management of this newly consolidated department is **J. C. Finley,** vice president. **Harold J. Kleen,** who has been, manager of domestic oil and gas exploration, has been named to the newly created position of geological advisor to the president. **John A. Masters** will continue as chief geologist for the company. **Breene M. Kerr,** formerly staff geologist, has been made manager of the Land Department, and **J. Val Connell,** formerly staff assistant to the vice president of oil and gas exploration, has been made assistant to the president.

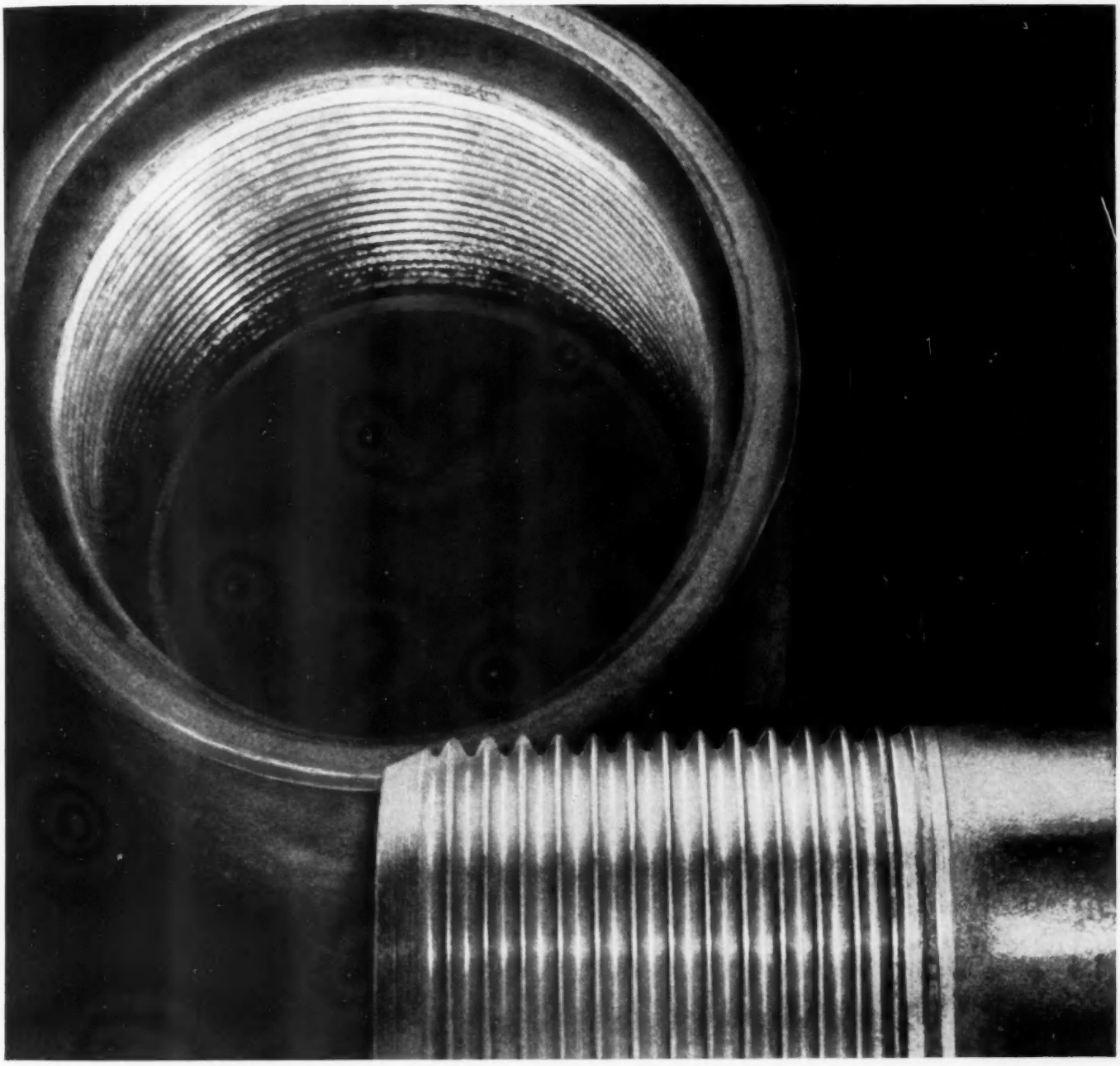
John M. Kelly, Roswell, N. M., has been appointed **Assistant Secretary** of **The Interior** for **Mineral Resources** by **President John F. Kennedy.**

John M. Kelly

A. J. Welborn

A. J. Welborn has opened an office in the **Browder Building** in Dallas and announced his entry in the field as an independent producer. He will continue to operate in West Texas, New Mexico and the Rocky Mountain areas, specializing in drilling blocks or farmouts and the purchase of producing properties.

J. S. Bell, R. C. Barbour, J. L. Loftis, J. C. Wilbourn, W. E. Dougherty and **J. C. Posgate** have been shifted to new managerial posts by **Humble Oil & Refining Company** for the company's Southwest Region. The region has been formed into four operating areas, with area offices in Houston, Dallas, Corpus Christi and Midland. Officers of the regional management and staff will be located in Houston. Bell heads the Houston area office; Barbour has been appointed regional production manager; Loftis has become regional exploration manager; Wilbourn has been named regional marketing manager; Dougherty will head the Corpus Christi area, and



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Men in the industry

the Midland area, which will include operations in the western states in the Southwest Region, excepting California, will be headed by Posgate.

Ivor Hayden Hughes has been appointed executive vice president of **Pan American International Oil Company.** Also, **Edgar E. Martin** was named general manager of Pan American International operating subsidiaries in Argentina, replacing Hughes.

Dr. Gilbert B. Carpenter has been retained by **Mobil Chemical Company, a Division of Socony Mobil Oil Company, Inc.,** as technical adviser. Carpenter will gather information on new products and process abroad. He will headquarter at the offices of **Mobil Oil Nederland N.V.,** Stadhuisplein 30, Rotterdam, Holland.

S. H. McManus, comptroller, and a 40-year veteran of the **Sinclair Oil Corporation,** has been elected a vice president.

Robert L. Gollnick, evaluation geologist, recently opened his consulting offices in Houston. For the past 10 years he had been senior staff geologist with Ralph E. Davis Associates, and prior to that had been senior evaluation geologist with Humble Oil & Refining Company.

W. E. Glenn

J. P. Malott

Wayne E. Glenn, Houston, and **J. P. Malott,** Los Angeles, have been elected vice presidents of **Continental Oil Company.** Glenn continues to make his headquarters in Houston and has become vice president and executive assistant to **Chas. A. Perlitz, Jr.,** executive vice president. He was formerly general manager of Conoco's Production Department. Malott, formerly general manager of the company's Western region, has made his new headquarters in Houston and has become vice president and general manager of production.

Theodore W. Nelson has been named named manager of production of **Socony Mobil Oil Company's** Exploration and Producing Department. He will advise management on all aspects of the company's producing activities. Nelson has been with Socony Mobil since 1934 when he joined the company as a petroleum engineer.

T. W. Nelson

Robert E. Chandler has been named district engineer in charge of the new **Oil Recovery Corporation** office at Midland, Texas.

O. L. Fursee, production manager of **Humble Oil & Refining Company's** Eastern Area, has been promoted to Southeast Regional production manager. Fursee and six other men will assist **R. H. Venn,** vice president in charge of the new region, and **C. G. Herrington,** regional general manager, in planning the complete regional organization. Others appointed to executive positions include: **E. A. Murchison, Jr.,** promoted to regional exploration manager; **E. M. Jolly,** manager of the Tennessee-Arkansas Area of the Esso Standard Division, named regional marketing manager; **C. N. Bailey,** assistant controller of the Humble Division, appointed regional controller; **William Grant, Jr.,** assistant manager of Employe Relations Department of the Humble Division, Houston, to regional employe relations manager; **Charles Janiver,** area attorney for the Eastern Area of the Humble Division, to regional general counsel, and **A. F. Kent,** information division head in the Public Relations Department of the Esso Standard Division, to regional public relations manager.

5 months of sand production fail to damage

CAMCO

Straight-Thru Design

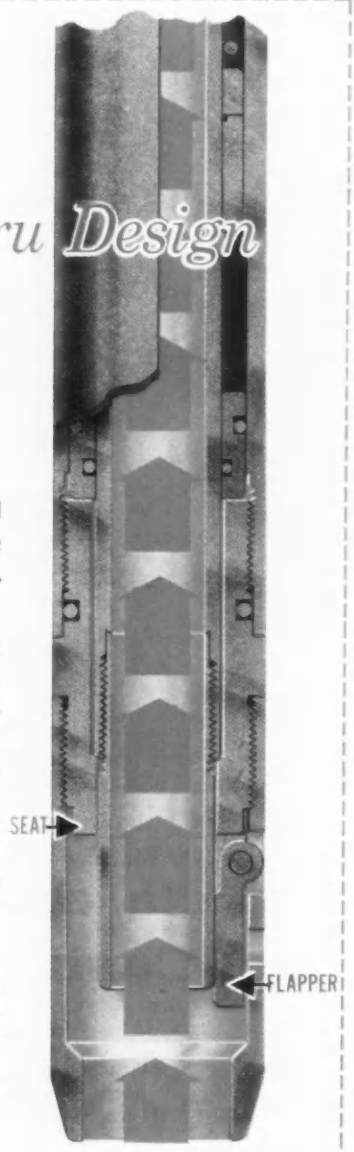
A-2 TUBING SAFETY VALVE

In a South Louisiana well, heavy sand production had repeatedly cut out subsurface tubing safety valves of conventional design, necessitating replacement every 60 days.

Then a Camco *Straight-Thru* design A-2 Safety Valve was installed. By its large straight bore and by location of the flapper and flapper seat outside the flow stream, *Straight-Thru* design reduces flow turbulence and protects vital seating surfaces against sand cutting. Pulled from the sand-producing well five months after installation, the Camco A-2 Safety Valve was found to be in perfect condition—ready for further duty!

Constant operating readiness for long periods of service make the Camco *Straight-Thru* A-2 your most reliable, positive assurance of automatic shut-in if surface controls should fail.

Your CAMCO representative will gladly tell you more about ***Straight-Thru*** *design and the other advanced features of A-2 Tubing Safety Valves. Ask him, or write for a complete brochure.*



Straight-Thru design reduces turbulence, protects valve seating surfaces against abrasion, assures proper closure of valve at predetermined pressure drop.

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"PRODUCING PETROLEUM PROGRESS"

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Box 14484, Houston 21, Texas

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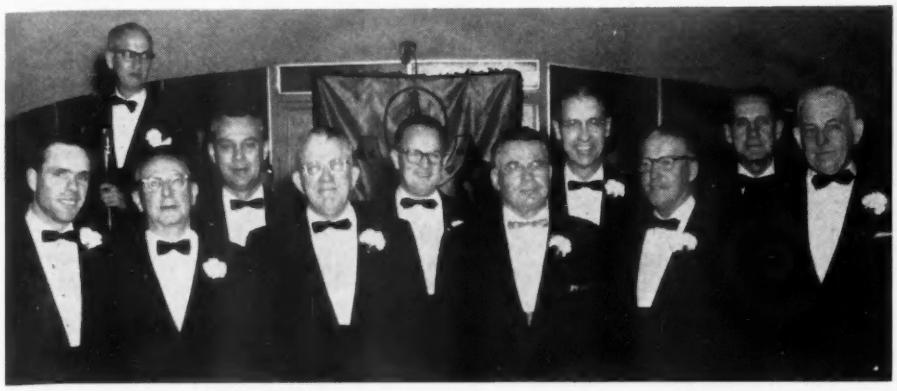
Associations



NOMADS Officers Installed in Tulsa . . .

New officers of the Tulsa chapter of NOMADS were installed at the annual banquet and ball. The new officers are (front row, left to right : Berwin Price, deputy sergeant-at-arms; Paul V. McGivern, senior regent; R. R. Mathews, treasurer; Thomas M. Lumly, president; Harry S. Horton, vice president, and W. O. Timberlake, junior regent. Back row (left to right) Don L. Collins, regent; J. J. Young, assistant treasurer; Larry Harper, assistant secretary; F. C. Cummings, secretary, and James S. George, sergeant-at-arms.

. . . and in Los Angeles

The 1961 officers of the Los Angeles chapter of NOMADS are shown at the Twenty-Second Annual Inaugural Ball held recently. Front row (left to right): Tom R. Ashe, Globe Oil Tools Company, regent; Taylor Bannerman, Technical Oil Tool Corp., regent; Charles M. King, Baker Oil Tools, Inc., president; Robert P. Gaylord, Wagner-Morehouse, Inc., master of ceremonies; Jack S. Smith, Byron Jackson Tools, Inc., vice president; Willard F. Goertz, Monarch Engineering Corp., deputy sergeant-at-arms. (Back row): Henry W. Pullman, Baker Oil Tools, Inc., senior regent; John Cochran, Driltol, assistant treasurer; Louis Q. Weber, Martin-Decker Corp., treasurer; Ray Elner, Kobe, Inc., secretary; Lee J. Laird, Ladish Pacific Division, sergeant-at-arms. Not shown, Neal B. Thompson, Ken Corp.

Oklahoma City to Host SEG Midwest Meeting

The Fourteenth Annual Midwestern Exploration Meeting of the Society of Exploration Geophysicists will be held in Oklahoma City April 9-11 at the Skirvin Hotel. In addition to the Geophysical Society of Oklahoma City, sponsor of the meeting, the Geophysical Societies of Tulsa, Shreveport, La., Dallas, Fort Worth and Midland, Texas, will also participate.

The theme for the meeting is "Geophysicis and Economic Oil Finding." T. H. Hulsey, vice president of the Chase Manhattan Bank will speak on "Valuation and Market Place." Other scheduled speakers are Robert A. Bishop, Oklahoma City independent geologist; Paul Lyons, chief geophysicist for Sinclair Oil and Gas Corporation; F. A. Van Melle, manager of the Geophysical Department for Shell Development Company, Houston, and D. M. E. McLarty, petroleum consultant, Denver. W. B. Robinson, Gulf Oil Corporation, Oklahoma City, is general chairman for the convention.

NAM Appoints Naden to Advisory Committee Post

William Naden, executive vice president of the Humble Oil & Refining Co., Houston, will serve as chairman of the

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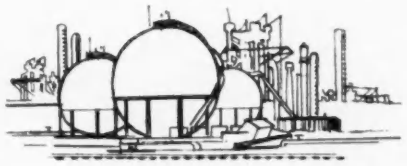
N. A.

DC-7B service between New Orleans and

Montego Bay
Aruba
Caracas

Deluxe Royal Service and Royal Scot Tourist on every flight—complimentary meals on both. Beverage service available.

Direct connections at New Orleans to and from Chicago • St. Louis • Texas and California.



DELTA AIR LINES

See your Travel Agent or call Delta

public relations advisory committee of the National Association of Manufacturers during 1961.

Naden, who has been a director of NAM the last two years, was a member of the public relations advisory committee last year. He is a director of Humble and formerly was president of Esso Standard Oil Co. until Esso became a division of Humble Oil last year.

As chairman of the NAM group, he and members of his committee will advise NAM on public relations policies and activities.

Denver SPE Officers

Fred Poettmann (left) Ohio Oil Research, is the new chairman of the Denver Section of the Society of Petroleum Engineers of AIME. Poettmann succeeds John Ferry (right) Denver-U.S. National Bank, who becomes a director. W. R. Smith (center), Colorado Oil & Gas Conservation Commission, was elected first vice chairman. Other new officials not shown are James Roe, Lufkin Machine & Foundry, second vice chairman; J. A. Mullinax, Schlumberger Well Surveying Corporation, secretary-treasurer, and L. B. Curtis Continental Oil Company, director.

J. D. Ponder Appointed OIC Area Chairman

J. D. Ponder, Humble Oil & Refining Company, has been appointed an Oil Information Committee Area chairman for 1961 and will administer the Community Programs Committee for Petroleum's "action" public information and service program for the 18-county South Central Area of Texas.

This service program provides speakers, films, demonstrations, informational materials and exhibits about the oil and gas industry to clubs and organizations and makes educational materials and services to students and teachers without charge.

Joining the more than 1,400 other Texas volunteer oil men and women in the Texas Mid-Continent Oil & Gas Association-sponsored program, chairman Ponder named Dwight E. King, also of Humble Oil and Refining Company, as chairman of the speaker's subcommittee.

Arizona Association Formed To Push Oil, Gas Industry

The Oil and Gas Association of Arizona was organized recently for the purpose of promoting discovery, development, production, transportation, refining and conservation of oil and gas, including helium in Arizona. The organizers who include petroleum operators, engineers, geologists, bankers and lawyers also have announced a second purpose which includes furnishing opportunities for open discussion and interchange of information concerning their original aims.

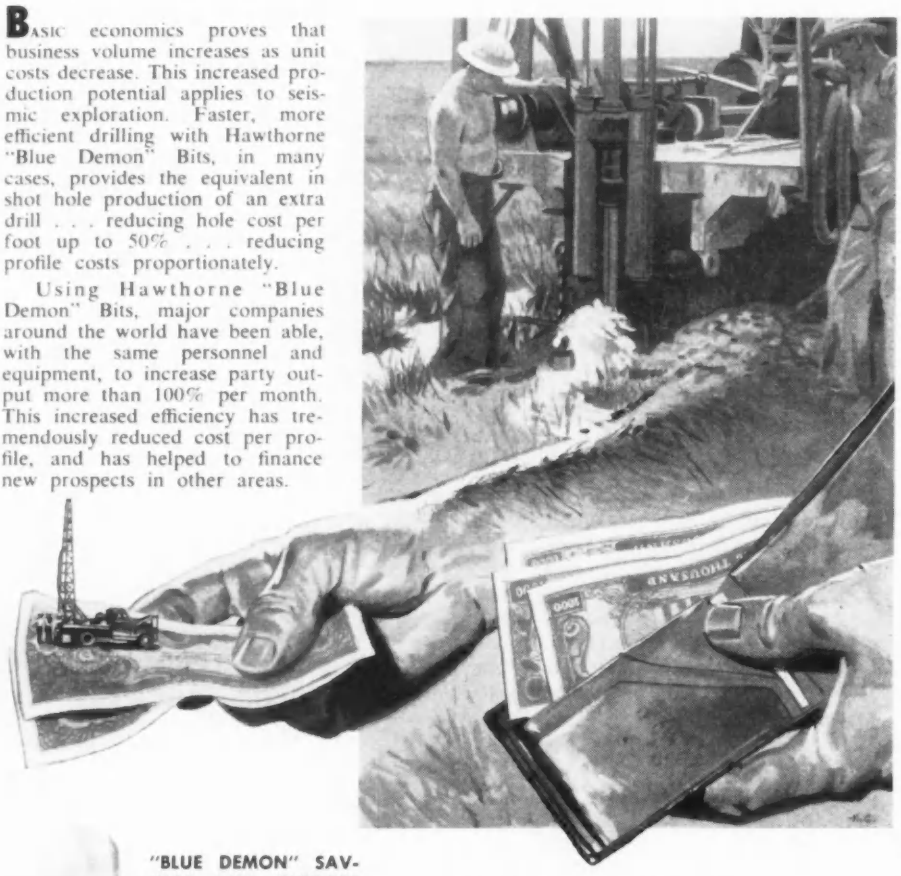
Association officers are W. T. Hudson,

ECONOMICS OF MORE EFFICIENT SHOT HOLE DRILLING — NO. 1

COST REDUCTION CREATES NEW BUSINESS
NEW BUSINESS CREATES NEW WEALTH

Basic economics proves that business volume increases as unit costs decrease. This increased production potential applies to seismic exploration. Faster, more efficient drilling with Hawthorne "Blue Demon" Bits, in many cases, provides the equivalent in shot hole production of an extra drill . . . reducing hole cost per foot up to 50% . . . reducing profile costs proportionately.

Using Hawthorne "Blue Demon" Bits, major companies around the world have been able, with the same personnel and equipment, to increase party output more than 100% per month. This increased efficiency has tremendously reduced cost per profile, and has helped to finance new prospects in other areas.



"BLUE DEMON" SAVINGS WILL SUPPORT FUTURE DRILLING PROSPECTS

Drilling conditions will vary, but you can count on decreased costs per profile . . . increased party potential . . . in increasing crew efficiency with "Blue Demon" Bits.

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308

Associations

Phoenix consulting geologist, president; Van D. Bennett, Valen Oil and Minerals Corporation, Phoenix, vice president, and Earl Rodman, Jr., Phoenix petroleum engineer, secretary-treasurer. The association's officers, plus Robert P. Davidson, Phoenix attorney and Gordon Fleetwood, Phoenix land and title oil and gas consultant, make up the executive committee. The association will meet monthly.

Five Members of PESA Elected Directors of API

Five members of the Petroleum Equipment Suppliers Association's Supply Group have been elected directors of the American Petroleum Institute.

Those elected to serve as directors through 1961 are A. W. McKinney, National Supply Company; W. H. Larkin, Larkin Packer Company, and L. B. Meaders, Halliburton Company. Members elected to terms expiring in 1962 are Elliott A. Johnson, Schlumberger Well Surveying Corporation, president of PESA, and John G. Seiler, Tube Turns, PESA, vice president.

Outstanding Geophysicists Nominated for Office in SEG

Ten of the world's outstanding geophysicists have been nominated for office in the Society of Exploration Geophysicists. Nominated for president is Richard Brewer, partner in the exploration and consulting firm of Reed & Brewer, Houston, who will oppose Dr. Lawrence Y. Faust, geophysical supervisor for Amerada Petroleum Corporation, Tulsa.

Dr. Milton B. Dobrin, staff geophysicist for Triad Oil Company, Ltd., Calgary, Alta., and Harold J. Kidder, chief geophysicists for Mobil Oil in Canada, Ltd., Calgary, have been nominated for first vice president. For vice president, Dr. John S. Sumner, chief geophysicist for Phelps-Dodge Corporation, Douglas, Ariz., will oppose Dr. Stanley H. Ward, associate professor of mineral exploration, University of California, Berkeley. Samuel R. Marsh, area geophysicist for Humble Oil & Refining Company, Shreveport, La., will run for secretary-treasurer against R. Maxey Pinson, division geophysicist for Union Oil Company of California, Midland, Texas. For the two-year term of editor, Dr. R. B. Rice, in the Denver research center of the Ohio Oil Company, will oppose John Bemrose, senior research geophysicist of Sinclair Research Laboratories, Inc., Tulsa.

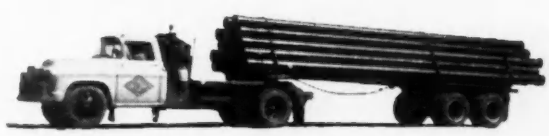
More than 3,600 active members out of 5,600 total world-wide SEG membership will be eligible to cast their ballots by mail in June, according to Dr. J. P. Woods, president and chairman of the SEG nominating committee. The officers elected at that time will start their terms next November during the thirty-first international meeting in Denver.

Congrats and $25 for this quip to CAROLYN KENEDY, Bells Wells Oil Company, Box 269, Miami, Oklahoma.

When it comes to shapeliness . . . Lone Star pipe proportions are right! All dimensions and qualities are strictly API specifications.

Lone Star Steel . . . America's most modern pipe plant . . . is Joe Roughneck's solid source of supply. Right here in the center of the oil country . . . quick availability of Lone Star pipe is a terrific convenience.

Neighbor, wherever you are, specify Lone Star and we both get a good deal.



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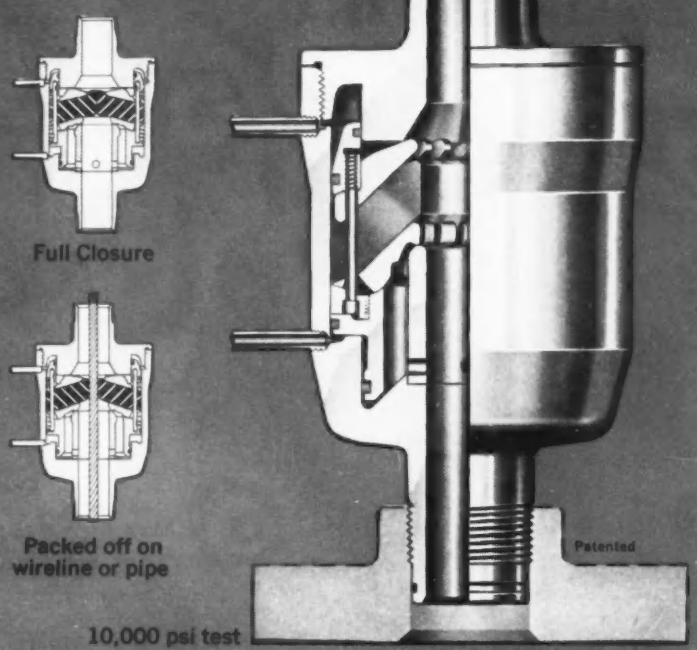
MAXIMUM
CONCENTRIC STRING WORKOVER
PROTECTION



2½" Model #5 CONICAL BLOWOUT PREVENTER

FULL CLOSURE
PACK OFF ON ANY SIZE, SHAPE
PUMPS PACKER OPEN OR CLOSED
LONG LIFE OF PACKER RUBBER

Regan® Forge & Engineering Co.

Quality - Wrought on the Forge of Experience

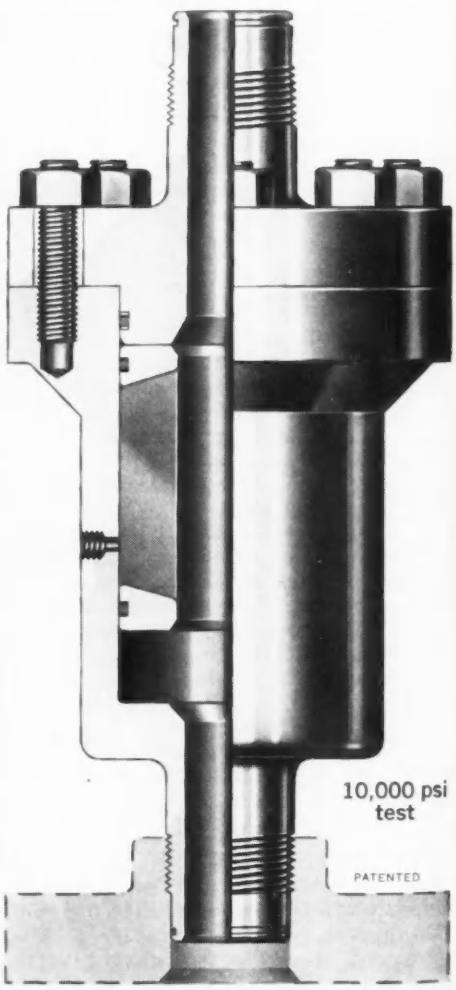
P. O. BOX 150 SAN PEDRO, CALIF.

Exclusive World Wide Distributors: MID-CONTINENT SUPPLY CO., FT. WORTH, TEXAS

For complete protection in concentric string workovers, use this Regan combination of safety-designed equipment:

REGAN CONICAL BLOWOUT PREVENTER: Tested to hold 10,000 psi well pressure around pipe or in a full closed position. Features steel fingers that are not moulded to the rubber element, thus allowing the rubber to flow to the inner bore without tearing itself; this design insures long life of packer element. Opening of the preventer is not dependent upon rubber resiliency; the rubber is positively pumped open.

REGAN "KF" STRIPPER: Tested to 10,000 psi around 1" pipe, the flexible Regan KF stripper's lower end floats like a piston. Well pressure, acting on the floating end, increases the pressure on the stripper.



2½" Model "KF" High Pressure Stripper
WELL PRESSURE ACTS AS PISTON TO HELP SEAL
RUBBER CAN ELONGATE TO ALLOW COUPLING THROUGH

Suppliers' notes

A. A. Prats, Jr.

Grady Howell

A. A. Prats, Jr., has been promoted to sales manager, Gulf Coast Division, **Tube-Kote, Inc.,** Tubular Sales Division. Included in his territory is Houston, Lafayette, La., and New Orleans. **Grady Howell** has been named to the same position for the Northern Division which includes the areas of North Louisiana, North Texas, Oklahoma and Arkansas. In Canada, **Joe Williams** has been named sales manager, Canadian Division, and is now responsible for all Tube-Kote Canadian sales.

A. T. Robertson has been promoted from personnel director to the newly created position of director of Industrial Relations of **Magnet Cove Barium Corporation.** Also, **Kenneth D. Reed,** formerly manager, Employment and Employe Benefits, has been promoted to the newly created position of assistant director of Industrial Relations.

Otis A. Brightwell has been placed in charge of **Oildex Services,** Fort Worth, a newly formed unit of the **Cardox Division of Chemetron Corporation.**

R. R. Rhodes

T. Davenport

Theodore Davenport has been appointed by the **Worthington Corporation's** Standard Pump Division as manager of planning, a new position. Also, **Robert R. Rhodes** has been named manager of sales.

Luther Roy (Red) Latimer has been appointed district manager for **Parkersburg Rig & Reel Company,** New Orleans. Latimer was formerly located in the Eastern Division, headquartering at Parkersburg, W. Va.

J. R. Bickerton, chief chemist at **Fletcher Miller Limited's** Hyde (Cheshire) plant, a member of the **Castrol Group of Companies, J. Birchenough,** works manager at Hyde, **R. A. Miller,** North London divisional sales manager and **S. V. Tilley,** senior technical representative for the Midlands and South Wales, have been appointed directors of Fletcher Miller Limited.

Robert F. Evans has been appointed vice president, engineering, of **Smith Tool Company, a Division of Smith Industries International Inc.**

Donald T. Koch is manager of the new Detroit branch sales office of the **Cooper-Bessemer Corporation.** The new office will serve eastern Michigan and northwestern Ohio areas of the corporation's East-Central sales district.

Paul Huffaker, Caribbean Oiltools, C.A., Puerto La Cruz, Venezuela, has been appointed sales and service representative for Venezuela, for **Oil Metering and Processing Equipment Corporation.** Huffaker will maintain, repair, replacement and maintenance parts in stock for Methol separating, treating and metering equipment, including separators, well testers, treaters, vol-u-meters, etc.

Paul Huffaker

Jess D. McClendon has been appointed regional manager of sales for **National Supply Division, Armco Steel Corporation.** Also, **E. G. Krig** was named regional manager of services and **Charles A. Chandler** was named regional manager of merchandising for the Western Region. The region's headquarters are in Torrance, Calif., and is responsible for the division's sales of oil field machinery and equipment in the western United States, includng Alaska and Hawaii. **Jerry L. Evans** is regional manager. At the same time, **R. Wesley Burns** was appointed regional manager. **D. L. Chandler,** regional manager of sales, **Glyn A. Hughes,** regional manager of services and **E. J. Bird,** regional manager of merchandising for **The National Supply Company, Ltd.** The company with headquarters in Calgary, Alta., serves as the Canadian arm of the National Supply Division, Armco Steel Corporation.

Allen F. Rhodes, vice president of engineering and manufacturing of **McEvoy Company,** Houston, and **Robert Eichenberg,** chief engineer, are the co-authors of a paper entitled "Pressure - Energized High Pressure Gaskets—Their Application to Petroleum Production Equipment," which will be presented at the **International Fluid Seal Meeting of the British Hydromechanics Research Asso-**

A. F. Rhodes

MARTIN RUBBER & DUCK RINGS give excellent life in dirty abrasive fluids . . . high or low gravity . . . much or little water . . . shallow or deep wells. They last for years in the easier pumping wells. Replacement rings cost comparatively little.

MARTIN PLUNGER BODIES, precision grooved, drilled and threaded (no underneath fluid passage), usually last for years. Tube or barrel costs are often cut in half.

The replaceable SYNTHETIC RUBBER GUIDES in MARTIN CAGES last longer than any metal, and the cushioning of the ball increases your ball & seat life. Results are often truly amazing. (Patent No. 2,591,174)

Write for our new catalog or see it in the Composite (24th Edition). All products sold thru supply companies.

JOHN N. MARTIN
Manufacturer
9 W. BRADY STREET • TULSA, OKLAHOMA

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers' notes

ciation in Harlow, Essex, England, April 17-19. Rhodes is a member of the Committee on Standardization of Valves, Fittings and Flanges, American Petroleum Institute. Eichenberg is a member of the Standardization Committee of the Association of Wellhead Equipment Manufacturers. Both are members of ASME.

F. T. Alexander has been appointed by **Hughes Tool Company** as manager of the newly formed Southern Region. He will headquarter in Houston. Alexander succeeds **Wade W. Hampton** who has retired.

In Preparation for the Oweco '25' Club's fourth anniversary annual dinner and outing June 24, club members are receiving a silver cup from The Oilwell Engineering Co., Ltd., managing director. The silver cup is the one time W. L. Mackenzie Bridge Cup, named for the founder of the company. (Left to right) N. Anderson, L. S. Dawson, H. Lee, A. Kelsall, C. Wood, H. Evans and W. Summerfield.

Oweco '25' Club Celebrates Fourth Anniversary June 24

Employes of The Oilwell Engineering Co., Ltd., Stockport, England, who make up the membership of the firm's Oweco '25' Club, will celebrate the fourth anniversary of the club's formation on June 24. Membership in the club ranges from shop laborers to the chief executive.

The Oilwell Engineering Co., Ltd., was founded in 1910 by William Lyon Mackenzie who operated a tool shop in Canada about the time the first major British oil companies were incorporated. Mackenzie foresaw their need for drilling equipment and moved to England, set up the Stockport works and engaged in the manufacture of machinery, tools and equipment for oil field drilling.

After completion of major plant extensions at Stockport on September 19, 1957, 62 employes, in the presence of members of the board, were awarded inscribed gold watches in recognition of their long and loyal service. This ceremony was the birth of the Oweco '25' Club. Leonard S. Dawson, managing director of the company, became the founder president of the club. The Club held its first annual dinner on June 6, 1958. In addition to the annual dinner of the club, essentially a winter function, on the twenty-fifth Saturday of each year a full day is taken by a summer outing.

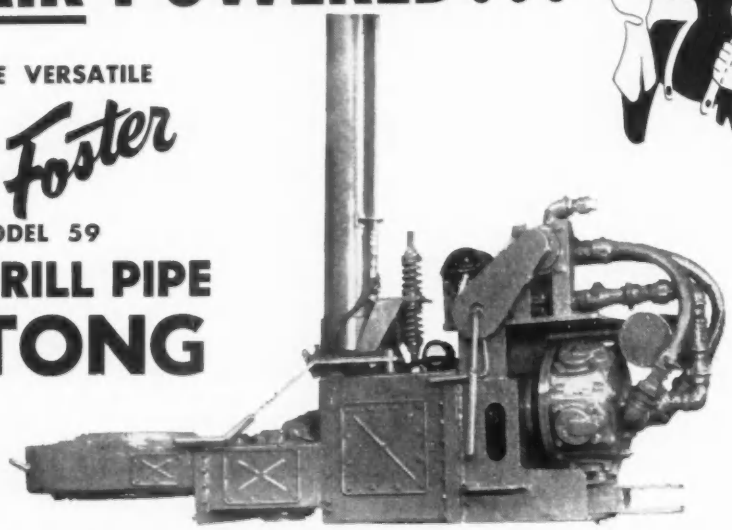
Zapata Off-Shore Gains Stock In National Tube Coating, Inc.

Zapata Off-Shore Company has announced the acquisition of a substantial stock position in National Tube Coating, Inc., Beaumont.

National Tube Coating has developed

NOW
AIR POWERED...

THE VERSATILE
Foster
MODEL 59
DRILL PIPE
TONG



DOES THREE BIG JOBS BY RUNNING YOUR
DRILL PIPE, CASING, & TUBING

The air powered FOSTER model 59 DRILL PIPE TONG will speed up your trips, protect your pipe, and make the derrick floor a safer place to work. All this adds up to PROTECTING YOUR PROFITS.

The hydraulic version of this tong was introduced at the IPE in 1959. Its success prompted the development of this air powered tong for rigs already equipped with air compressors. One major oil company has already ordered their second Model 59 air tong to run drill pipe and casing.

Think of stepping up your company's efficiency and profits by contacting us for particulars, TODAY.

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F. M. Farrier.....Wichita Falls, Texas
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Garlick Sales & Service....Oklahoma City, Oklahoma
Texas Warehouse Service.....Corpus Christi, Texas
R. D. Cloninger.....Lafayette, Louisiana
L. W. Mauck.....Great Bend, Kansas
W. O. Nelson.....Farmington, New Mexico
Coastal Engineering Co.....Bakersfield, California
Moore Sales & Service Company....Casper, Wyoming
Joe Perry.....Salem, Illinois
T. C. McDonald.....Shreveport, Louisiana
Leidecker Tool Co., Ltd..Edmonton, Alberta, Canada
Langley Y Cia. Srl.....Buenos Aires, Argentina
East-West Oil Tools C. A.
Maracaibo & Anaco, Venezuela
Rooks Oil Field & Engr. Supply Co., Ltd.
San Fernando, Trinidad, T. W. I.

Suppliers' notes

a unique process for plastic coating the interior of tubular goods used in the drilling and completion of oil and gas wells to combat corrosion. According to the announcement, this process has proven particularly economical in offshore wells.

The present management of National Tube comprised of O. C. Galloway, president; F. H. Smith, vice president, and R. Wolpert, controller, will continue their direction of company activities. Howard Duke, assistant to the president of Zapata, was elected to the board of directors of National Tube Coating on February 20.

Baker Oil Tools Initiates Technical Advice Program

Baker Oil Tools, Inc., has initiated a program whereby trained design engineers will be permanently assigned to most of its districts throughout the United States and to many foreign areas.

R. A. Kent

The first of these positions was filled March 1, when R. A. (Bob) Kent was transferred to Baker's West Texas District headquarters in Odessa. Kent's responsibilities under J. T. Mitchell, district manager, will be to supply Baker customers with technical advice on new products, performance data on existing products, information on complex technical hookups and assistance to any jobs where difficulties are encountered.

Reed-Dresser Merger Off; Announce New Reed Directors

The proposed merger of Reed Roller Bit Company and Dresser Industries has been cancelled, and John Maher, president and chief executive officer for Reed, has announced a new board of directors for the firm. The new directors will be submitted to the annual meeting of the stockholders.

The new Reed board is composed of Dr. Le Van Griffis, dean of engineering, Rice University; Harry A. Hassan, vice president, Sinclair Oil and Gas Company; Charles I. Francis, a director and counsel to the president of Texas Eastern Transmission Company; David T. Searls, partner in the Houston law firm of Vinson, Elkins, Weems and Searls; Cecil N. Cook, partner in the Houston law firm of Butler, Binion, Rice and Cook; W. L. Doherty, partner in W. L. Doherty and Company, a Houston insurance firm; J. A. Grundy, vice president of Reed Roller Bit Company; Dow D. Warren, vice president of Reed, and John Maher, president of the company.

(More Suppliers' Notes on Page 169)

Now
The new Hardy-Griffin 1" "WS" Connection is the ONLY joint specially designed for concentric workover operations
HARDY-GRIFFIN
ENGINEERING CORPORATION
A Division of Atlas Bradford Company
3600 Yoakum Blvd., Houston 6, Texas, Tel. JAckson 6-1901
Midland, Odessa, Dallas, Texas; New Iberia, Harvey, La.;
Oklahoma City, Tulsa, Okla.

For more data on advertised products, use Readers' Service Cards, last page.

McCULLOUGH

SALINITY LOG

with scintillometer®

...a nuclear log that tells
OIL *from* SALT WATER

The McCullough Salinity Log determines the presence and degree of saline fluids in formations surrounding the bore-hole. It will distinguish between oil and salt water and can be used in open or cased hole. Providing hole diameter is not extreme, it may be used where air or gas or highly saline fluid was used for drilling.

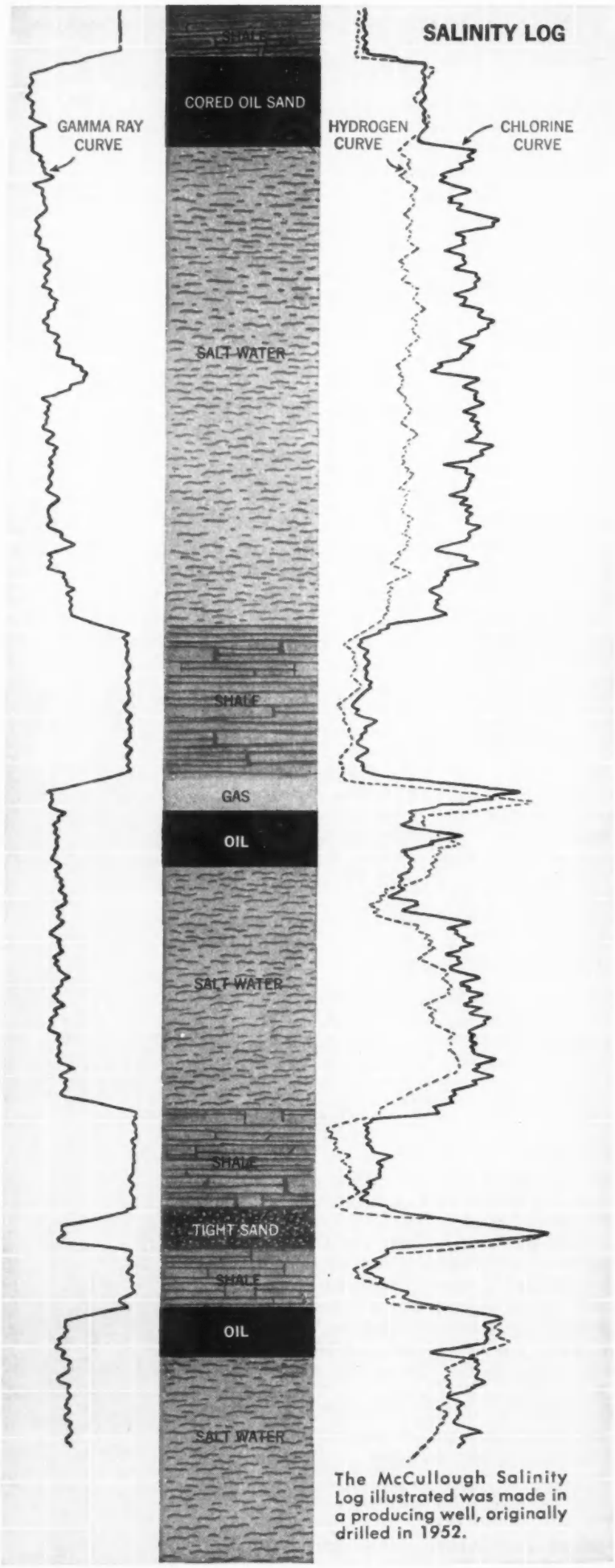
A "chlorine" curve and a "hydrogen" curve are recorded simultaneously at the same depth elevation with a single detector. These curves are compared to indicate the amount of salt, NaCl in particular, that is present in the formations being investigated. In potential oil bearing formations the absence of salt is indicative of the presence of oil.

The recording of the two curves simultaneously is considered essential. It eliminates the possibility of a depth discrepancy between two curves which are recorded separately. It also insures the recording of information under identical physical conditions—of extreme importance in interpreting the two curves.

A higher counting rate and greater instrument efficiency allows an increased spacing (23½ in.) between the source and the Scintillometer. This provides the added benefit of a proportionately larger zone of investigation.

Take a look at these features:

- **Distinguishes between salt water and oil in liquid bearing formations.**
- **Determines the degree of salinity in formation fluid.**
- **Identifies salt water zones that must be blanked off.**
- **Makes possible water saturation calculations for potential oil bearing zones.**
- **Shows salt water and oil zone contact under suitable conditions.**
- **Aids in determining gas/oil contact.**
- **Helps determine if it is economically practical to set casing on new completions.**
- **Aids in evaluating correct depth to set casing string.**
- **Accurately re-evaluates old wells to locate potential cased-off production.**
- **A reliable tool for porosity determination.**



The McCullough Salinity Log illustrated was made in a producing well, originally drilled in 1952.

McCullough

TOOL COMPANY

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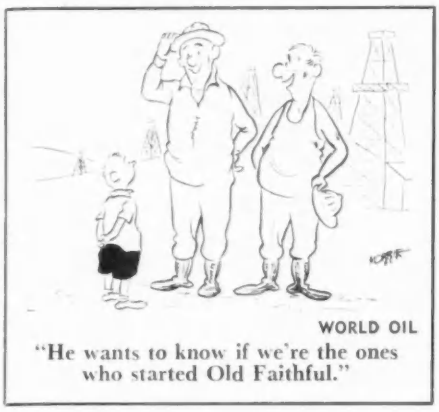
SQUEAKS

From the Bull Wheel



WORLD OIL

"He wants to know if we're the ones who started Old Faithful."

Self-Made Man

The self-made millionaire was addressing a graduating class: "All my success in life," he said, "I owe to one thing—pluck, pluck, pluck."

"That's great, sir," spoke a voice from the rear, "but will you tell us something about how and whom to pluck."

It's the Truth

Nature gives everyone five senses: touch, taste, smell, sight and hearing. Everyone needs two more—horse and common.

Keeping Ahead of—

The boss was feared by his staff for the caustic memos he wrote. One day one of his assistants discovered to his horror that he'd given the executive the wrong figures. Fearfully he wrote to the boss:

"In answer to your memo of tomorrow."

Oh, They Have Ways

A charge account is what a woman uses to keep her husband from becoming too independent.

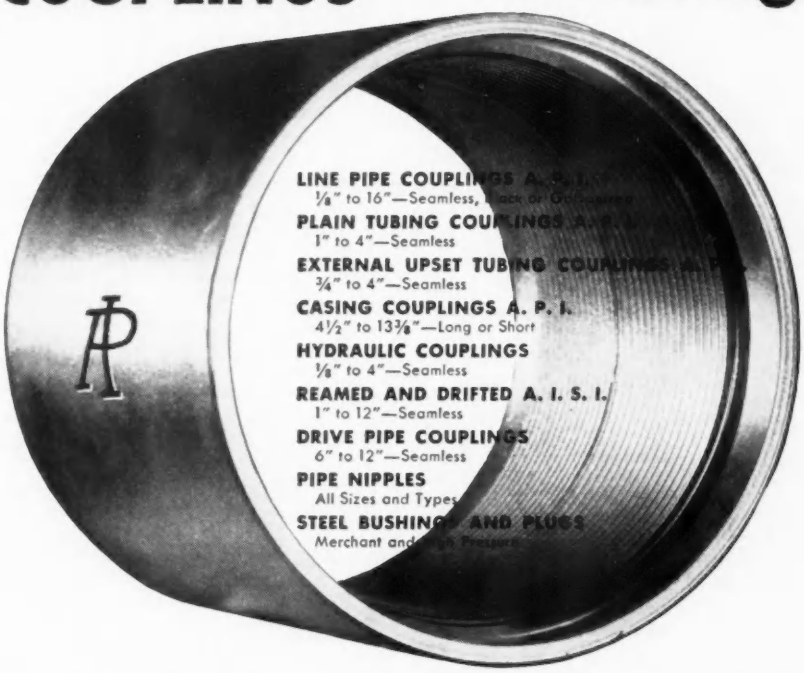
Has This Ever Happened?

A frustrated motorist had been trying to pass a huge truck for many miles. Every time he tried to go around, the truck driver increased his speed or swerved toward the middle of the road. Finally, at a stop sign, the motorist pulled alongside the truck driver's window.

"Well?" growled the truck driver, glaring viciously.

"Nothing important," was the motorist's reply. "I know what you are—I merely wanted to see what one looks like."

COUPLINGS BY Wheeling



WHEELING MACHINE PRODUCTS CO.

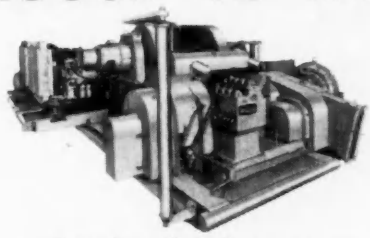
Wheeling, West Virginia

West Coast Factory: Woodlake, California

Don't fight it...

CHECK

WILSON SUPER MOGUL "42" RIG



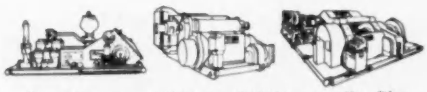
• Priced well below any comparable competitive rig

Wilson

WILSON MFG. CO., INC.

Wichita Falls, Texas • The Home of RED IRON

Winchmobiles Traveling Blocks Speedwinches



Slush Pumps 3000' to 25000' capacity Rigs

ANOTHER PRODUCT WITH PROVEN PERFORMANCE PIONEERED BY

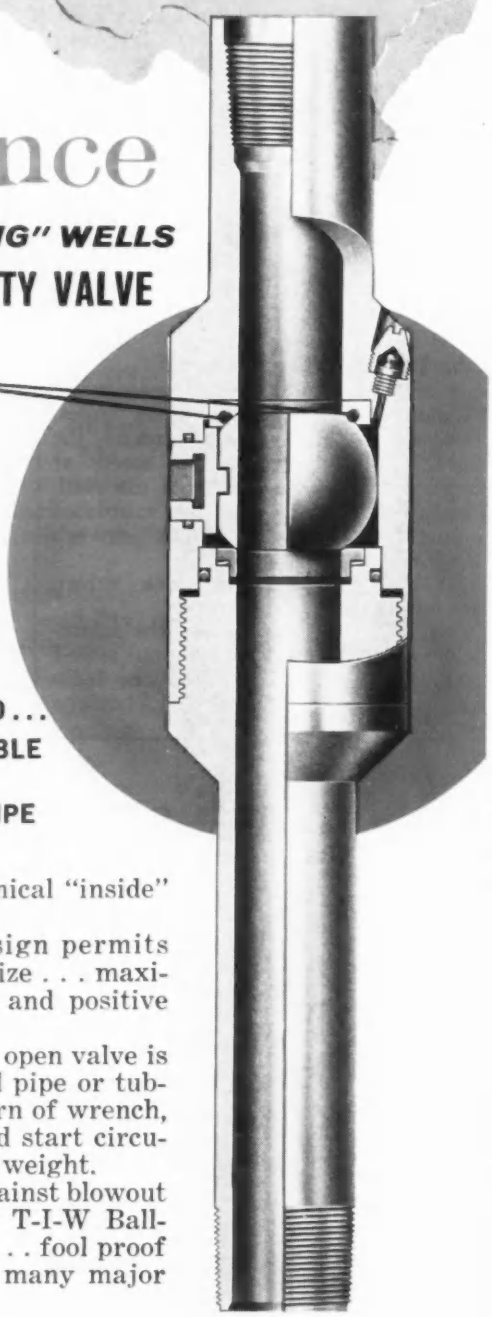
TIW

INSIDE

Safety Insurance

TO CONTROL "KICKING" WELLS

T-I-W BALL-TYPE SAFETY VALVE
with High Pressure
TEFLON SEAT



- SMALL DIAMETER
- FULL OPENING
- EASILY OPENED AFTER CLOSING
- 10,000 lb. TEST STANDARD... HIGHER RATINGS AVAILABLE
- FOR TUBING OR DRILL PIPE

A safe, dependable, economical "inside" blowout preventer.

The special ball-type design permits great strength in the small size . . . maximum ease of operation . . . and positive seal at the Teflon Seat.

When a blowout threatens, open valve is stabbed into top joint of drill pipe or tubing . . . then closed by a ¼ turn of wrench, connect kelly, open valve, and start circulation to restore proper mud weight.

Proven safety insurance against blowout through the drill string, the T-I-W Ball-Type Safety Valve is simple . . . fool proof . . . standard, for years, on many major drilling programs.

Manufacturers of: T.I.W. Portable Rigs . . . T.I.W. Safety Joints . . . T.I.W. Rotary and Casing Slips . . . T.I.W. Grief Stem Safety Valves . . . T.I.W. Packers for every purpose . . . T.I.W. Pump Chambers . . . T.I.W. Mudmixers . . . and many other oil field tools.

TIW TEXAS IRON WORKS

GENERAL OFFICE and MAIN PLANT: 1401-1423 Maury Street, P. O. Box 16068, Houston 22, Texas. Other Shops at Victoria and Corpus Christi.
EXPORT REPRESENTATIVES: Val R. Wittich, 30 Rockefeller Plaza, New York, N.Y.
IN VENEZUELA: Oilfield Sales & Service, S. A., Anaco & Maracaibo
IN CANADA: Garrett Oil Tools, Ltd., Edmonton, Alberta

133

The Knocks of Life

"See that lump on the side of Willie's head," little Willie's sister informed the teacher, "that's where Daddy helped him last night with his arithmetic lesson."

Anthony and Er. . Er. .

"You say Tony gave up his job as a traveling salesman—why?"

"It seems his wife wanted her Tony home permanent."

Some's Got It and Others Ain't

"Fifty thousand dollars!" exclaimed his friend, "Isn't that a lot of money for a prefabricated hunting shack?"

"Yes," admitted the Texan, "but I told them I wanted it right away and so they shipped it airmail."

A Real Conversationalist

The man who can describe a shapely girl without using his hands gets credit for having a wonderful vocabulary.

Definitions Not in Webster

Conceit—"I" strain.

Trouble—Opportunity in work clothes.

Minor Operation—One performed on someone else.

Honeymoon—The morning after the knot before.

Las Wages Nights

Two Hollywood producers were watching the star of a Las Vegas show. "I wonder who made her dress," said one of them admiringly.

"It's hard to say," said the other, "Probably the police."

Socialized Medicine

When women get together at a card party to talk about their operations.

They're Only Kid. . ing

One little boy to another: "I'm so tough I wear out a pair of shoes in a week."

Second boy: "I wear out a pair of jeans in a day."

Third boy: "I wear out my grandparents in an hour."

Weights On Your Mind

Wife (reading husband's fortune card): "You are a leader of men. You are brave, strong-willed and popular with the opposite sex. It's got your weight wrong, too."

SECONDARY RECOVERY

PETROLEUM ENGINEERS
STEPHENS ENGINEERING
WICHITA FALLS, TEXAS

RESERVOIR ENGINEERING
Water Flooding Gas Repressuring
EVALUATION CORE ANALYSIS
SURVEYS ECONOMICS
Cost Estimates, Design, Installation
FIELD SUPERVISION
Phone 723-2167

Suppliers' notes

Lucey Products Acquires Milhoan Drilling Stock

Lucey Products Corporation, Tulsa, has acquired all the drilling equipment including three rotary rigs and all miscellaneous accessory stocks of Milhoan Drilling Company, Tulsa. The announcement was made jointly by E. S. Calvert, Jr., vice president of Milhoan, and W. O. Timberlake, vice president, machinery sales of Lucey.

The drilling rigs involved in the transaction are in West Texas and New Mexico. Milhoan Drilling has been one of the pioneer contractor concerns operating in the greater Mid-Continent area the past two decades.

New Cat Engine Dealer Announced by Caterpillar

Zagst, Inc., a new engine dealer in Texas, has been announced by the Engine Division of Caterpillar Tractor Company. Headed by Charles O. Zagst, the new dealership assumed operations earlier this year.

C. O. Zagst

Located at 7125 Navigation Boulevard, Houston, Zagst, Inc., will provide sales, parts and service for all the full line of Caterpillar Diesel and natural gas engines.

Midway Supply Company Appointed Gaso Distributor

Midway Supply Company, Jackson, Miss., has been appointed by Gaso Pump & Burner Manufacturing Company, Tulsa, as distributors of its pumps in the states of Michigan and the province of Ontario, Canada.

Equipment Leasing Company Newly Formed Houston Firm

A new company, INELCO, or International Equipment Leasing Company, has been formed by J. M. Lebeaux of Houston, Bruce and Curtis Calder, Jr., of Dallas.

INELCO was formed to aid producers in the present price squeeze. It frees working capital while providing modern cost-cutting equipment necessary for efficient and profitable production. Under INELCO's system to purchase and lease all types of production equipment to the oil and gas industry, the operator specifies the equipment, vendor and price desired. INELCO then purchases the equipment according to the producer's instructions and it is delivered to the specified location.

Lebeaux is president of the new firm and is the former manager of Research and Development at Oil Center Tool Company. The Calders are partners operating Horizon Oil & Gas Company of Dallas.

WORLD OIL'S Trading Post CLASSIFIED ADVERTISING

RATES: Regular Classified (undisplayed) **set in this size type: 20 cents per word. Minimum charge $4.** Blind box address in our care counts six words. Replies forwarded without charge. **Display Classified ads,** set in suitably larger type with ruled border, $13.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All classified ads payable in advance.** Send copy and checks to: Trading Post Classified Section, World Oil, P. O. Box 2608, Houston, Texas.

FOR SALE

■ 2500 Failing 5 X 10 pump, diesel power. Failing 1500 propane, complete. Reply WORLD OIL Ad Box 222-W, Houston, Texas.

EQUIPMENT WANTED

■ Wanted Failing 1500, drill pipe, mud pump, 45 or 55' mast, pay cash. Fred E. Butler Box 481 Pueblo, Colo.

SITUATIONS WANTED

■ PALEONTOLOGIST: 44, single, desires overseas position with oil company. 15 years experience with Tertiary and Cretaceous Foraminifera, and ammonites, in California, Colombia, and Libya. Some field and wellsite work. Knows Spanish, learning Arabic. Send Inquires to Box 224-W, WORLD OIL, Houston, Texas.

LEASES, DRILLING, ACREAGE, ETC.

■ Approximately 4,000 acres near North-Platte, Nebraska to assign for rental and drilling commitment. Contact-1710 West A, North Platte, Nebraska, LE 2-5237.

■ Cumberland County, Kentucky-250 acre lease near two shallow wells flowing over 400 barrels per day. Price-7.50 per acre. Small override. Write-wire-phone: W. V. Cravens, Russell Springs, Kentucky.

■ Capital needed to drill offset production in West Texas. Possible dual completion. Wells less than 3,200 feet deep. Lovera Exploration Co. Box 8024 Dallas 5, Texas.

NOTICES, SERVICES

■ Representation offered to U.S. Petroleum Company interested in starting operations in New Zealand or Australia by Drilling Supervisor presently in Canada. Many years experience and contacts in both countries. Write Box 223-W, WORLD OIL, Houston, Texas.

■ FINANCIAL—Investment Banking Houses and Underwriters reached. Confidential. You can send the details of your proposition direct or thru your attorney to Consultant 817 - 51st Street, Brooklyn, N. Y.

ROYALTY

■ Royalty Buyers — income producing gas-distillate royalty, new, deep, dual completed wells, with additional sands behind the pipe. Ogden Oil Company, P.O. Box 409, Ph. EL 2-3353, Taylor, Texas.

FOR RENT

ALDRICH PLUNGER PUMPS
Skidded with Drivers
Available for RENTAL
POWER SPECIALTY CO.
2000 Kipling St.
HOUSTON 6, TEXAS

MAPS

CONCESSIONS & OPERATIONS
Mid-East * Africa * Europe * Caribbean

Our famous Map of Near & Middle East Oil 6th Ed. (1960 statistics) now available. World's most detailed coverage (concessions, oil- and gasfields, pipelines, refineries, and projects). Also other area maps. B. Orchard Lisle Industrial Cartography, 621 Majestic Bldg., Ft. Worth 2, Texas.

Manuscripts Wanted

Have you written a book you would like to have published? Do you have an idea or an outline that you would like to talk over with a publisher? Gulf Publishing Company, publishers of World Oil, Petroleum Refiner and Pipe Line Industry magazines, and numerous technical books, is actively seeking trade and technical manuscripts for publication by its rapidly expanding Book Division. For further information write to Manager, Book Publishing, Gulf Publishing Company, P. O. Box 2608, Houston 1, Texas.

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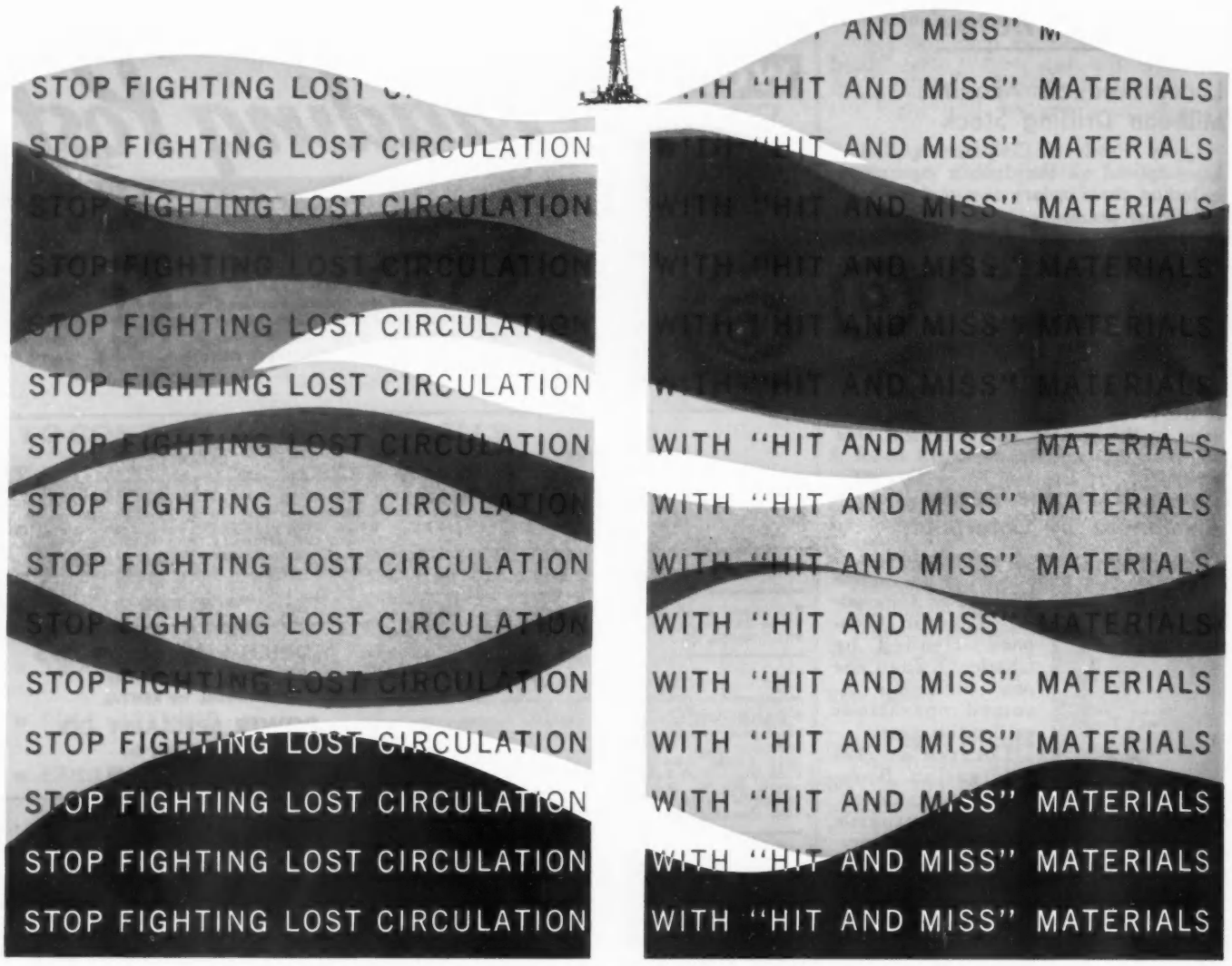


10 years of research and testing have perfected a quick, positive sealer!

Cert-n-Ceal®

(A PRODUCT LICENSED FOR SALE BY MACCO, CORPORATION, PARAMOUNT, CALIFORNIA.)

A patented product, Cert-N-Ceal is the first Lost Circulation material scientifically formulated to provide:

- **instant mechanical action**
- **powerful, delayed swelling qualities**
- **sealing capabilities that strengthen with pressure**

A strong granular substance, it is hydraulically non-compressible under fluid pressures up to 10,000 psi. Cert-N-Ceal is entirely inorganic, contains no high pH materials, and will not ferment or decay. Having a dry density of nearly 70 lbs./cu. ft., it is easily mixed — in minutes — in all muds and cements. Using 30 lbs./bbl. or more, Cert-N-Ceal can be added through hoppers or compounded in suction pits with guns. It is packaged in 50 lb. multi-wall bags for convenient, safe handling.

Next time — let Cert-N-Ceal solve your Lost Circulation problem. Eliminate costly mechanical difficulties.

see Cert-n-Ceal in action!

Write or phone for a free motion picture product demonstration.

distributed internationally by the KEN corporation

NEW equipment and services

Tubingless Completion Tools

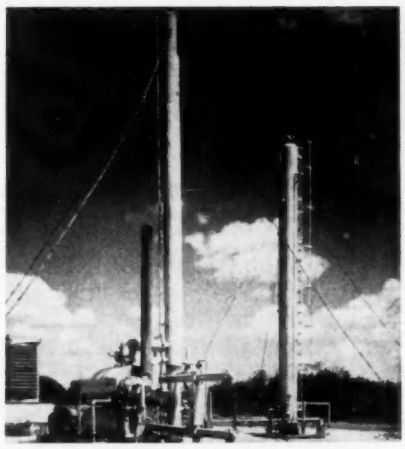
An extensive line of tubingless completion tools has been made available. The T-I-W Type AH Packer features the T-I-W Automatic Bottom, which eliminates left hand rotation of tubing while setting or releasing. With or without hydraulic holddown slips, AH Packer features a one-piece mandrel and ring-type packing elements, for positive seal against high pressures. Can be set, released and re-set without affecting the efficiency of the packer. (Texas Iron Works, Inc. Supplements data on Pages 5221-5256, 1960-1961 Composite Catalog.)

For more data, circle E1 on postcard

New Foaming Agent

Development of a new and highly effective foaming agent for use in air drilling of oil wells beset by water encroachment has been announced. Armomist, a liquid cationic surfactant, will produce large quantities of a stable, light density foam and is not affected by high concentrations of dissolved solids. It is a highly fluid substance with a pour point below 0° F so that it can be used at extremely low temperatures. It may be injected in the air stream either directly or in a carrying medium of lime water. (Armour Industrial Chemical Company.)

For more data, circle E2 on postcard



Gas Desulphurizing Unit

The design of this new automatic gas desulphurizing unit has been simplified to provide trouble-free operation and economical maintenance. Unit removes hydrogen sulfide and carbon dioxide from gas by absorbing the acid gases in a solution of monoethanolamine in water. Unit can operate unattended, requiring only supply gas to actuate pneumatic valve and fuel gas for the reboiler. Operates efficiently under all climatic conditions. (Maloney-Crawford Tank & Mfg. Co. Supplements data on Pages 3463, 1960-1961 Composite Catalog.)

For more data, circle E3 on postcard

New Tool Joint Compound

Gulf Tool Joint Compound, a new protective coating lubricant for drill pipe threads for shallow and moderate depths has been introduced in

IT'S HERE THE REALLY NEW

Available in 2-, 3-, 5- and 10-gallon sizes.

Gotkool® lined with MARLEX®
RIGID POLYETHYLENE

Seamless lid and liner formed from MARLEX® (Rigid Polyethylene). Keeps drinkable liquids HOT or COLD for unbelievable time.

Liner — outside container and bottom backed by Isofoam molded in place. Will withstand terrific abuse.

Neoprene grommet assures perfect seal.

Nylon faucet, flush mounted, will not transmit heat.

Neoprene stop washer easily replaced.

A Gotkool lined with Marlex withstands temperatures of 210° above to 150° below zero. It is sanitary — pure — easily cleaned — seamless — will not corrode.

H. P. GOTT MANUFACTURING CO.
WATER CANS AND COOLERS
P. O. BOX 702 • WINFIELD, KANSAS

Now...Jet Washing and Cementing with Rotary's New Multi-Purpose Tools

JET WASHING— JET CEMENTING SUB

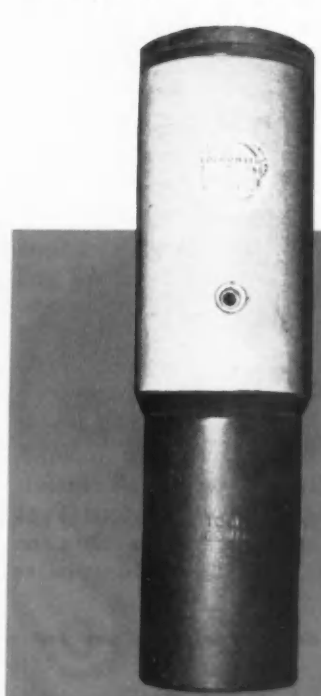
Use this tool on the drill string with a bit, mill, or any desired tool on the bottom. Clean out, jet wash and jet cement in *one* round trip.

JET WASHING— JET CEMENTING LINER MILL

Mill the hanger, mill the liner, jet wash and jet cement in *one* round trip.

JET WASHING— JET CEMENTING CASING SECTION MILL

Locate the collars, mill the casing section, jet wash and jet cement the hole in *one* round trip.



These three new Rotary Multi-Purpose Tools have been designed and developed to save rig time by eliminating round trips, and give better end results.

The Rotary Oil Tool Company "Lockomatic" Hole-Opener and Section Mill has never been stuck in a hole due to cuttings fouling the mechanism or failing to unlock.

Write today for specifications and information.

Rotary Oil Tool Company

Serving the industry over 20 years

8655 Whitaker Avenue, Buena Park, California
LAmbert 6-4621 • Cable ROTOILTOOL

Why a Burns Liner Hanger?

With the advent of seamless alloy casing, drill pipe protectors, roller bearing bits, weight indicators, greater table speeds and other improvements in drilling practices, came a period of development of the liner hanger. Full oil strings from the top to the bottom of the well were abolished as needless expense and a wasteful practice.

It remained for the Burns Tool Company to develop the first truly scientific, safe, dependable liner hanger. One that was positive in setting and releasing action, that would stay where it was set, and that could easily be retrieved.

The Secret of Positive Dependability of the Burns Liner Hangers 100% slip contact—The entire area of each slip contacts the casing, guaranteeing a secure, solid grip.

100% slip support—The entire area of each slip is completely supported by the strength of the hanger body itself. This is a guarantee against slip breakage and promotes the efficiency of the liner hanger.

The secret of positive dependable hanger operation lies behind the slips. The Burns safety hangers are the only ones that are scientifically designed to provide perfect concentricity—100% slip contact—between the slip and the slip recess in the hanger body throughout the entire length of slip travel. The cut-away view below illustrates the slip and slip recess construction. Note that the slip actually receives the full support of the hanger body at all times, the "bridged" construction of the slip assembly. Not only is each slip completely supported by the hanger body, but also the sides of the slips are supported and guided by grooves in the slip recess. Construction of this type assures absolute dependability—support from the hanger body guarantees perfect slip contact with the casing at all times. Efficiency plus safety.

Write today for complete product catalog

BURNS TOOL COMPANY

Sold through leading supply houses

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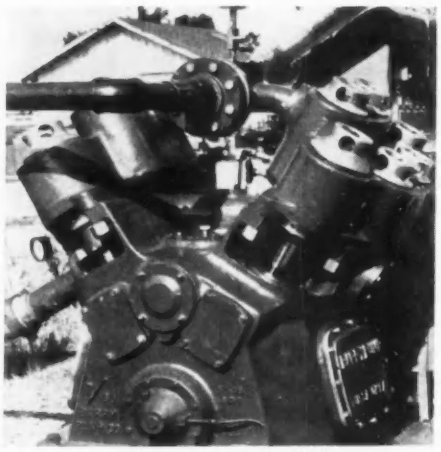
Santa Maria, Casper

New equipment

the Southwest area by the manufacturer. Special additives to increase tackiness in the new compound insure that a coating will remain on the pipe after it is broken, to protect against rust. Product has excellent anti-galling properties and high resistance to water penetration. (Gulf Oil Corporation.)

For more data, circle E4 on postcard

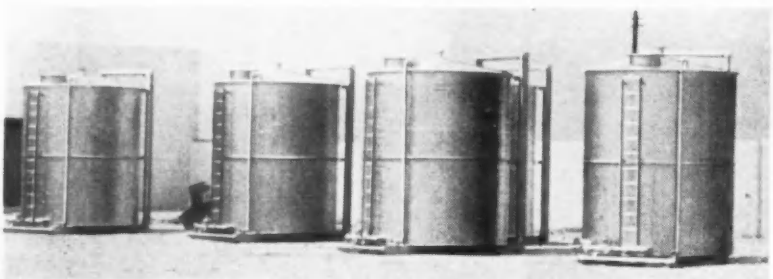


Quadruplex Plunger Pumps

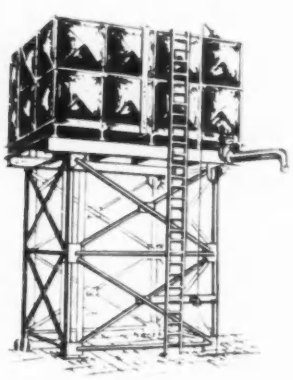
New Barry V60 Quadruplex Plunger Pumps are now available from 150 to 1,250 hp and 100 to 1,300 gpm in five frames, sizes, with eight models trimmed for any service. Power frame of one piece cast construction with heavy cross bracing gives maximum rigidity and strength. Features: pump has replaceable packing cartridges and permits a quick, easy change in plunger size without changing the fluid head; direct drive with flexible gear ratio for compactness and higher mechanical efficency. (Barry Pump Company).

For more data, circle E5 on postcard

API tanks Braby



Braby are authorised manufacturers of A.P.I. sectional tanks to specification 12B. These are obtainable plain or galvanized and fitted with suitable skids, if desired. Other types and sizes can be custom-built to order. Braby also supply pressed steel 4′ x 4′ sections to manufacture rectangular tanks of all capacities, complete with steel towers built to specification, if required. Write for full particulars.



FREDERICK Braby & COMPANY LIMITED
OILFIELD DIVISION
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CRAYFORD · LIVERPOOL · GLASGOW · BRISTOL · UXBRIDGE
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Braby of BRITAIN

New Type Oil Seal

Use of this new type of oil seal has made possible sealed-in-oil lubrication of wristpin bearings on pumping units, in place of the former grease-gun lubricants that required frequent field servicing. Seal has two hardened ferrous metal sealing rings that maintain oil-tight, self-adjusting-for-wear contact under constant pressure from two specially compounded oil-heat-cold resistant rubber "O" rings. (The Parkersburg Rig & Reel Co., Division of Parkersburg-Aetna Corp. Supplements data on Pages 4413-4436, 1960-1961 Composite Catalog.)

For more data, circle E6 on postcard

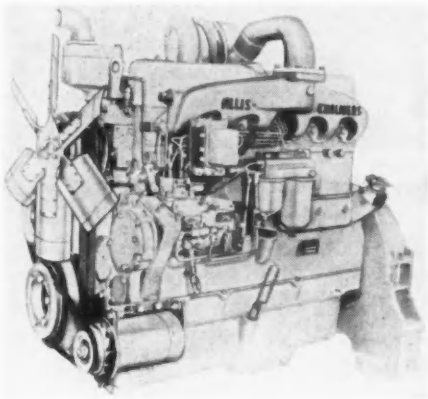
New Rotary Hose

A revolutionary new "Gold Stripe" rotary hose, pretested 50 percent in excess of the 5,000 psi Class C American Petroleum Institute test, has been developed. Its "cable-lock" design utilizes steel cables which are counter-wrapped around the hose for reinforcement. The hose performs at any required pump pressure and still has

New equipment

plenty of reserve strength to prevent costly and dangerous blow outs. (Thermoid Division, H. K. Porter Co., Inc. Supplements data on Pages 5257-5264, 1960-1961 Composite Catalog).

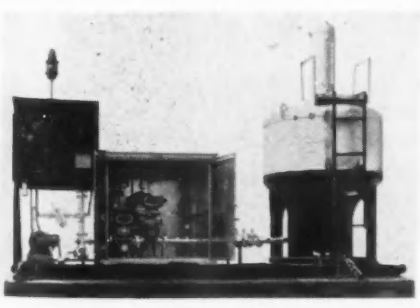
For more data, circle E7 on postcard



New Diesel Engine

This Model 11000, 210 hp turbocharged engine has been added to the diesel engine line of Allis-Chalmers. It has a horsepower rating of 2,200 rpm. Model 11000 operates on as little as .366 pounds of fuel per bhp/hr, or up to 27 percent less fuel than other engines of similar horsepower. Key to this operating efficiency is the Allis-Chalmers direct-injection, open chamber combustion system with controlled turbulence that thoroughly mixes fuel and air for complete, fast and even combustion. (Allis-Chalmers Manufacturing Co. Supplements data on Pages 170-171, 1960-1961 Composite Catalog.)

For more data, circle E8 on postcard



New LACT Unit

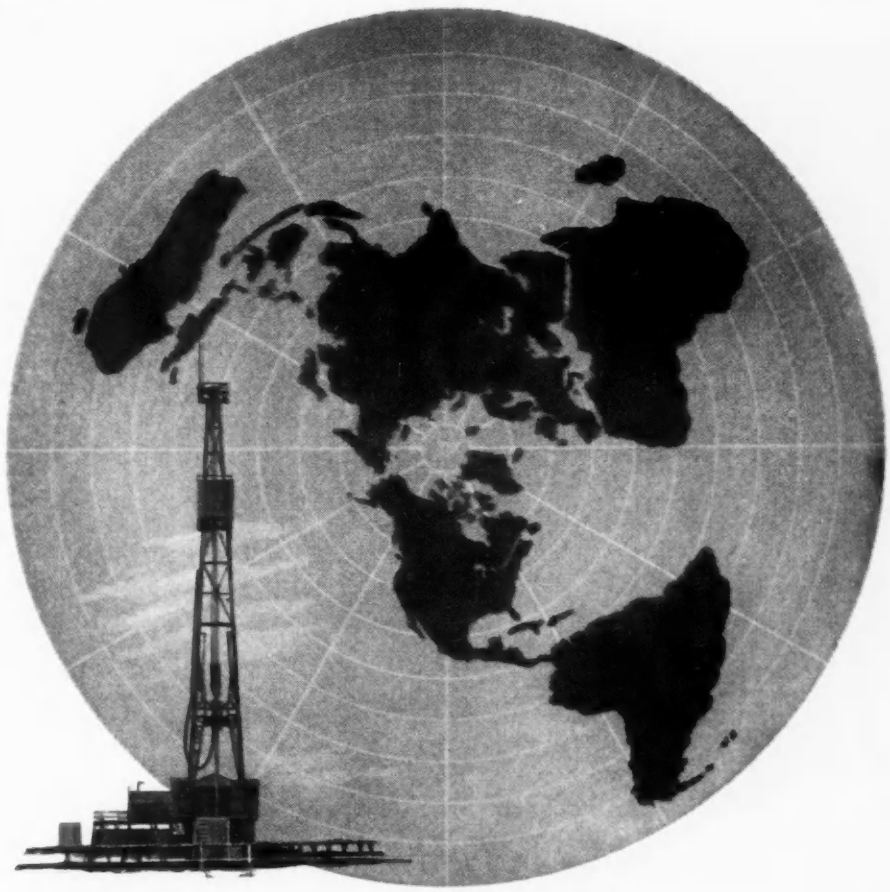
This Lease Automatic Custody Transfer Unit with positive displacement meter, which meets requirements of both producers and pipe lines, according to the manufacturer, requires only four connections for operations: (1) inlet line; (2) pipe line delivery line; (3) rejected oil line; and (4) electric power input. A back pressure and shut off valve insures accurate meter operation and positive control. (National Tank Company. Supplements data on Pages 3977-3996, 1960-1961 Composite Catalog.)

For more data, circle E9 on postcard

New Slim-Hole Pumps

A new line of subsurface pumps for slim-hole completions is now available. "Little Squirt" is the only pump line on the market available in a full range of slim-hole completion sizes, according to the manufacturer. Designed with the stamina and dependability of regular-sized pumps, they are available in four-rod pump sizes and five-tubing pump sizes, with metal or cup plungers. Can be run in either single or multiple-string wells with 1¼-inch or 1½-inch tubing. (Harbison-Fischer Mfg. Co. Supplements data on Pages 2438-2439, 1960-1961 Composite Catalog.)

For more data, circle E10 on postcard



RIGS AROUND THE WORLD...

- one of the first contract drilling companies to operate internationally
- rigs for every depth and formation requirement
- skilled personnel with sound management
- a logical choice for your drilling project

DRILEXCO Dallas

Drilexco rigs and crews are now operating in Alabama / California / Kansas / Louisiana / Mississippi / New Mexico / Texas / Brazil / Costa Rica / Holland / Iraq / Libya / Nigeria / Portuguese Guinea / Turkey.

DRILLING AND EXPLORATION COMPANY, INC.

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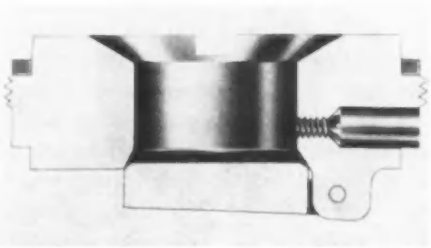
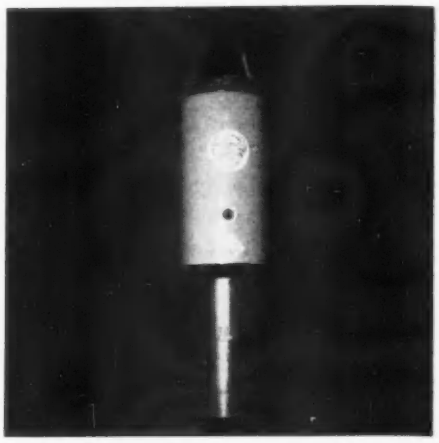
New equipment



Insert Type Float Valve

Two new valves, an insert type float valve, pictured, and an insert type circulating Filrite valve, have been added to Larkin's line of primary cementing equipment. Made from strong, easily drillable aluminum alloy, the new valves are for installation in the casing coupling between the pin ends of the casting. Float valve is equipped with a flapper valve of proved efficiency and strength and designed for use when a conventional float collar is not considered necessary. (Larkin Packer Co., Inc. Supplements data on Pages 3241-3244, 1960-1961 Composite Catalog.)

For more data, circle E11 on postcard



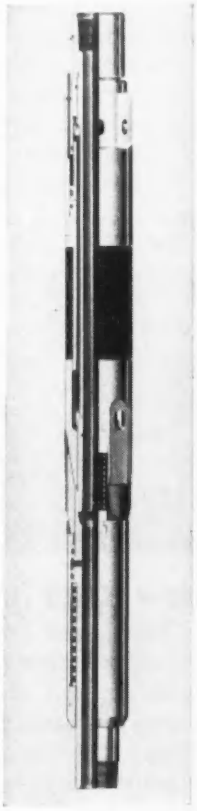
Jet Washing-Cementing Sub

A new development in dual-purpose tools is this Jet Washing-Jet Cementing Sub. Sub is made up on the drill string with a bit, mill or any desired tool on the bottom and run in the hole. Hole is cleaned out or drilling operation completed. Without pulling drill string, hole is jet-washed and cemented, as well as cleaned out, all in one trip. For export purposes, tool can be maintained in the field with the use of replacement packs and a few hand tools. (Rotary Oil Tool Company. Supplements data on Pages 4793-4796, 1960-1961 Composite Catalog.)

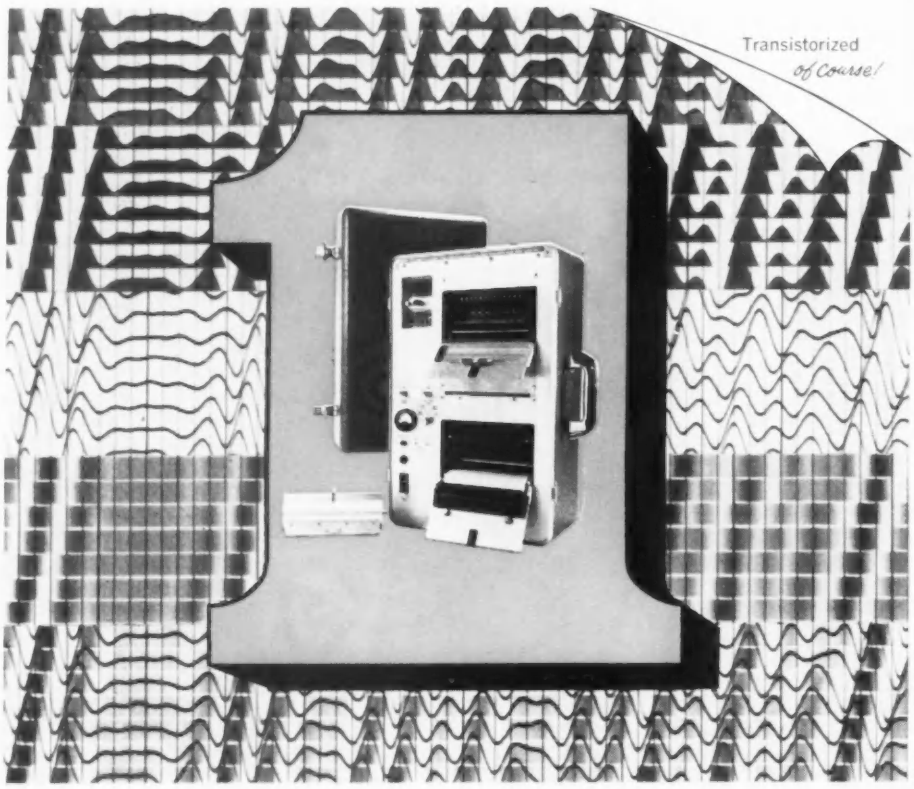
For more data, circle E12 on postcard

Surface Controlled Valve

A new surface controlled annulus valve is available. The valve has been designed for use where the casing annulus is employed as a flow conductor and can be installed in tubing 200 feet below the wellhead. One-eighth-inch tubing can be extended to the surface for pressuring the valve open. Slips can be set by pressuring the tubing string at the surface, enabling the packer element to be appropriately loaded. (Page Oil Tools, Inc. Supplements data on Pages 4369-4388, 1960-1961 Composite Catalog.)



For more data, circle E13 on postcard



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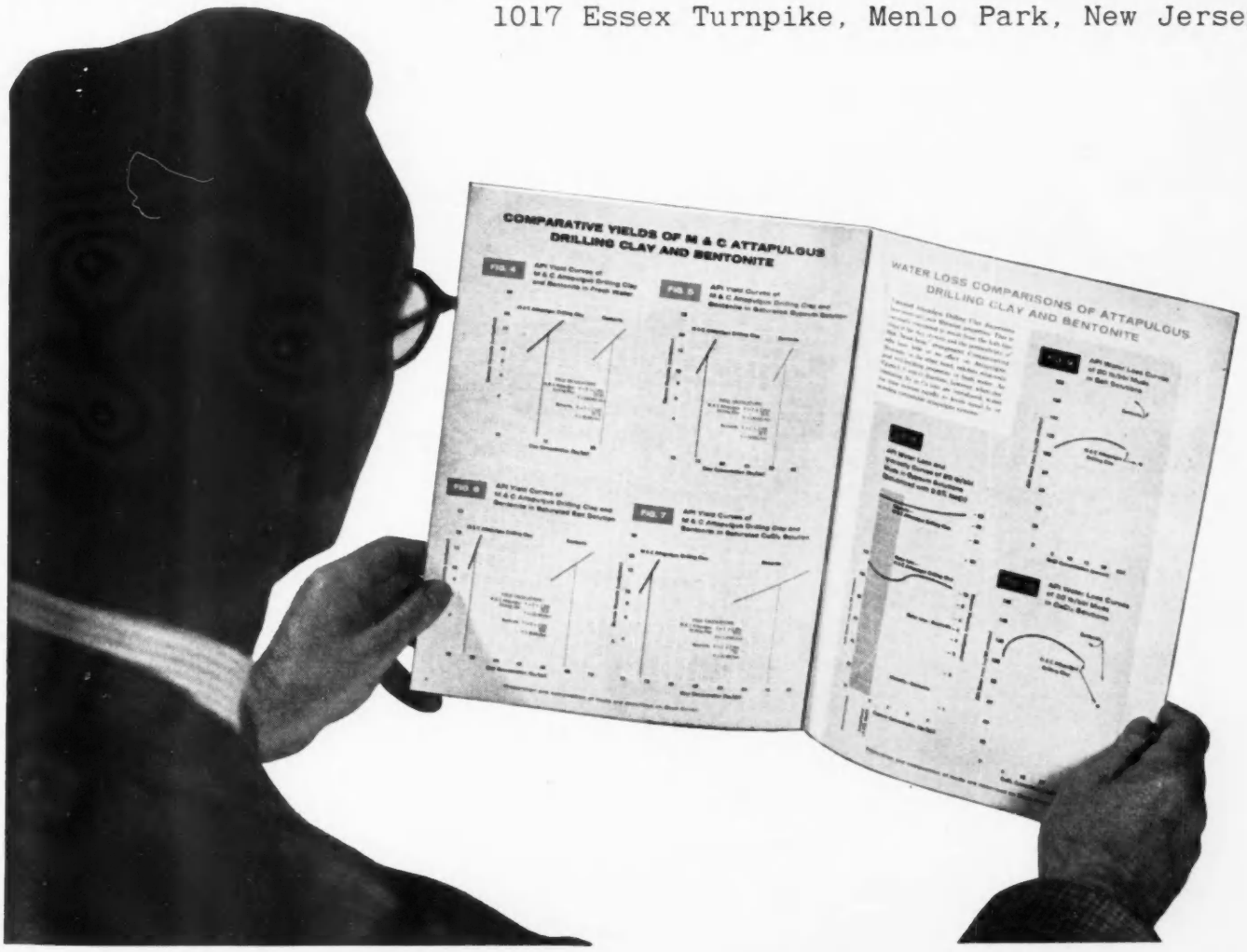
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New literature

To get your copies, circle key numbers on postcard and mail to WORLD OIL.

Lubricated Valves

An eight-page brochure providing complete instructions for lubricating and servicing Rockwell - Nordstrom valves has been issued by Rockwell Manufacturing Company. The three-color brochure describes by text and step-by-step illustrations, the proper method of lubrication for all the types of Rockwell-Nordstrom lubricated plug valves, the correct adjustment of valves, how to repack Hypreseal valves with plastic stem packing, etc. A chart of recommended lubricants, photos and description of Rockwell's lubricant dispensing equipment are also included.

To get a copy, circle E14 on postcard

New Pipe Data Sheet

A new fold-out data sheet on tubing joints, Catalog No. DS-61, is available from Hardy-Griffin Engineering Corporation. Folder gives API tubing data, API casing data, calculations of running clearance in casing, multiple tubing installations using one size, stress table, mud table, tubing formula and thread forms.

To get a copy, circle E15 on postcard

Diesel-Electric Power

Ruston & Hornsby, Limited, has available a new booklet giving detailed information, illustrations, specifications and diagramatic data on its line of diesel engine-driven generator units especially applicable for electricity generation on either a continuous or emergency standby basis. Units are powered by Ruston YE Diesel in ranges from 50 to 175 horsepower with electric battery starting.

To get a copy, circle E16 on postcard

Services Offered

A six-page brochure describing the services offered by Plastic Applicators, Inc., has been made available. Pipe inspection services and equipment are illustrated. Products and services of Plastronics Division, the Electronics and Instrumentation Division, Rubber Applicators, the Molded Rubber Products and Rubber Lining Division, are also described.

To get a copy, circle E17 on postcard

Phosphate Compound

Gypban is the brand name of complex phosphate compounds described in a new product data sheet recently released by Dowell Division of The Dow Chemical Company. Gypban is used to retard deposition of gyp in and near well bore, on down hole equipment and on surface well equipment. Data sheet tells what Gypban does, where it is used, its advantages, physical properties and how to use it.

To get a copy, circle E18 on postcard

Temperature Recorders

A new catalog recently published features the subsurface pressure and temperature recorders manufactured by The Kuster Company. Literature includes gage clocks, micrometer chart readers, fishing tools, replacement parts and supplies. A 24-hour rental service is also described.

To get a copy, circle E19 on postcard

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OILFIELD FLOAT

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Float on 11.00 x 20 — 14-ply tires.

OILFIELD TRUCK AND FLOAT

Scammel Constructor 261" wheel base Oilfield Truck.

Hands-England 75,000 lb. capacity tandem axle Oilfield Float 30' 0" long and 9' 6" wide folding support legs and inverted 36" fifth wheel.

Truck and Float on 14.00 x 20 — 18-ply tires.

OILFIELD FLOAT

Hands-England 25,000 lb. capacity single axle Oilfield Float 24' 0" long and 8' 0" wide, folding support legs and SAE king pin 11.00 x 20 — 12-ply tires. Steel stake sides.

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